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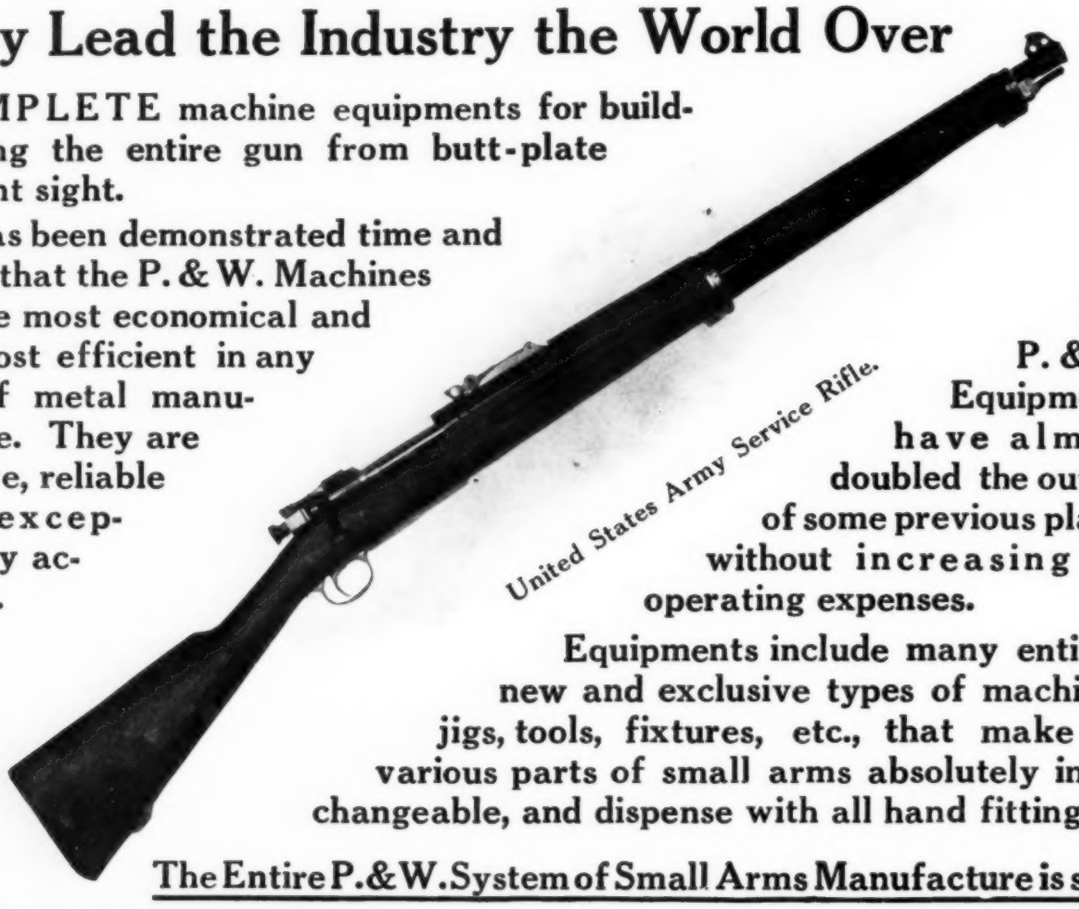

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(*See pages* 59, 60, 61, 62, 63 *and* 64)

Dies Used in Making Fishing Reels

By E. A. Dixie

Tools used to make a complete fishing-reel body and seat in one piece, thus reducing the number of parts for this piece from eleven or more to one.

Tools for making reel-body ends and novel method of driving them in the lathe.

Through the courtesy of Meiselbach Brothers of, Newark, N. J., I am able to show some very interesting press tools used in their factory for the production of one type of their fishing reels. Fig. 1 at *J* shows the finished reel, which will no doubt be recognized by the readers of this article. It is an improvement on the reel shown at *K* as it contains but 32 parts all told, while the other is made up of over 55 separate pieces and as the two ends are fastened together by small screws with distance pieces or posts between, the reel is liable to shake loose and fall apart under stress of use, which is impossible with the reel shown at *J*,

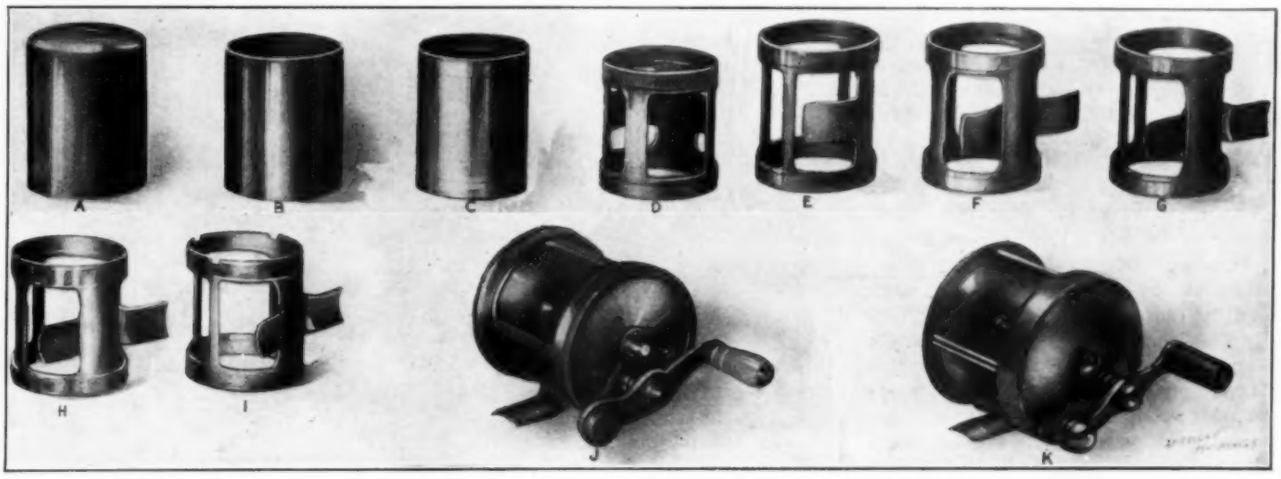


FIG. 1. THE REEL IN VARIOUS STAGES

Fig. 1. The drawing operations which produced the sample shown at *A*, Fig. 1, are so well known that it will not be necessary to go over them here. *A* is a brass cup which is drawn up in the usual way; the top is cut off to produce *B*. The two ends are then enlarged as shown at *C*. This is done by a sectional die which holds the body while a punch above and below expands the two ends. The piece *C* is then perforated as shown at *D*. This is done in a self-contained sub-press die and punch shown in Fig. 2. The horn *A* carrying the punch is secured to the slide *B*. Underneath the sub-press is shown a similar horn *A* and die *C* with its attached stripper *D*. The stripper can also be seen in the die mounted on the sub-press and marked with the same letter. As the horn *A* is considerably overhung, it is impossible to apply sufficient pressure to do the perforating without springing it. To overcome this tendency to spring a pressure piece *E* is held in the ram of the press, the flat *G* of which comes in contact with the top of the slide *B*, while the adjustable pin *F* on the end comes in contact with the flat on the end of the horn *A*. The blank similar to *C*, Fig. 1, is pushed by the operator over the horn until it comes against the stop *J*, no locating sidewise being necessary for the first stroke. The press then descends and punches out the first large opening, the piece is then turned until the stop *I* comes in contact with one edge of the opening which has just been punched. This indexes the piece for the next stroke which punches out the second large opening. These operations are repeated on the whole lot. The dies are then changed and using *H* as a stop the small openings shown at the back in *D*, Fig. 1, are punched out in the same way. *D*, Fig. 1, is then taken to the punch and die shown in Fig. 3, in this the two ends

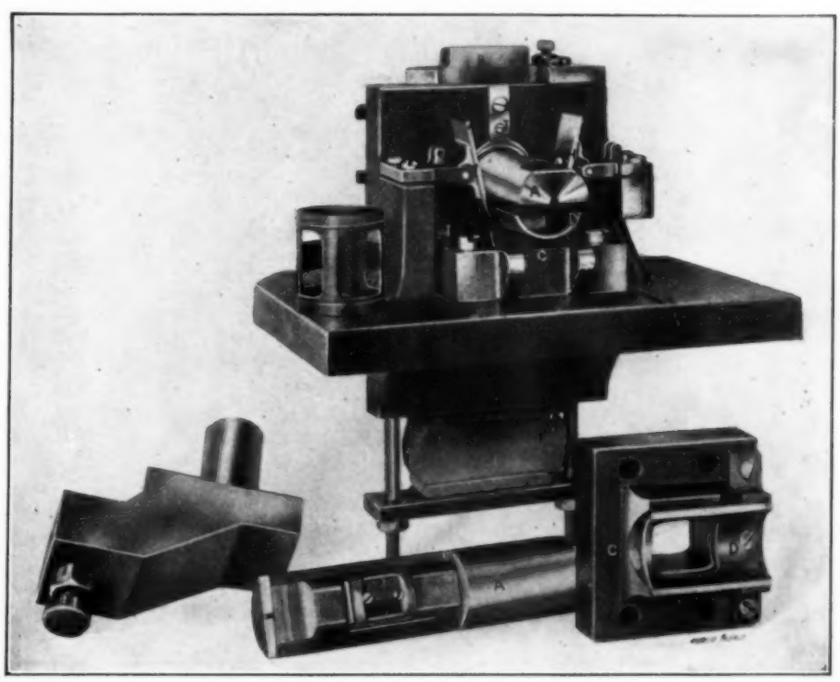


FIG. 2. PUNCHES AND DIES FOR THE OPENINGS

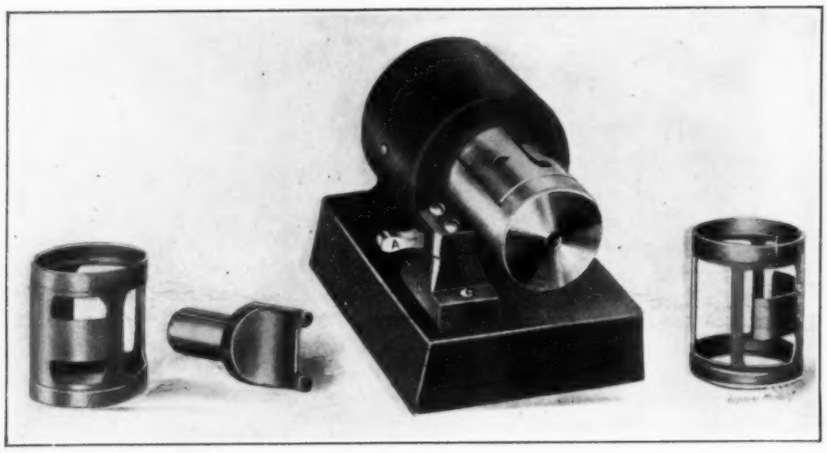


FIG. 3. PUNCH AND DIE FOR RELEASING THE REEL SEAT

of the piece which fits the reel seat in the completed reel are released from the body of the cylinder, and after this operation the piece is as shown to the right in Fig. 3. To the left the blank is shown. *A* is the stop which locates the blank by the center post. The piece then goes to the punch shown in Fig. 4 which expands the two wings *A* of the blank shown to the left. The punches *B* and *C* pivot on the pins *D* and *E* and are swung out by the wedge-shaped piece *F* as the ram of the press descends, taking with them the wings *A*. The handle *G* controls the wedge *H* at the back, which clamps the blank in position by means of the wedge-shaped piece *F* while it is being operated on. *I* is the stop to locate the work central. Fig. 4 shows the piece in place in the die.

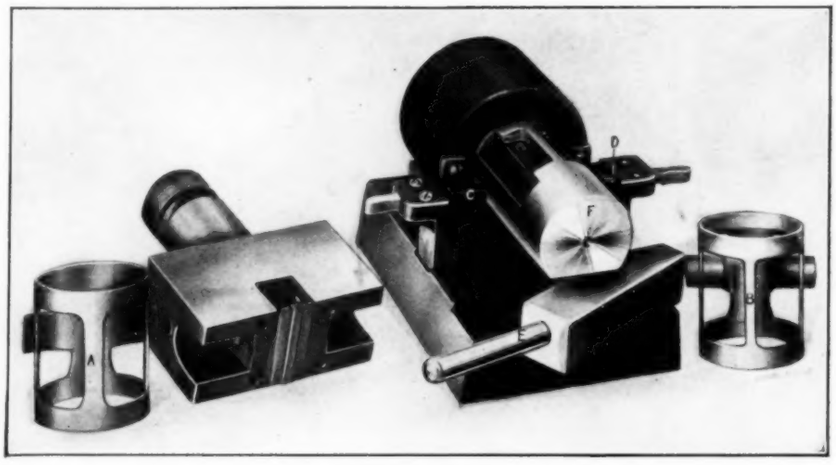


FIG. 5. TRIMMING THE POSTS

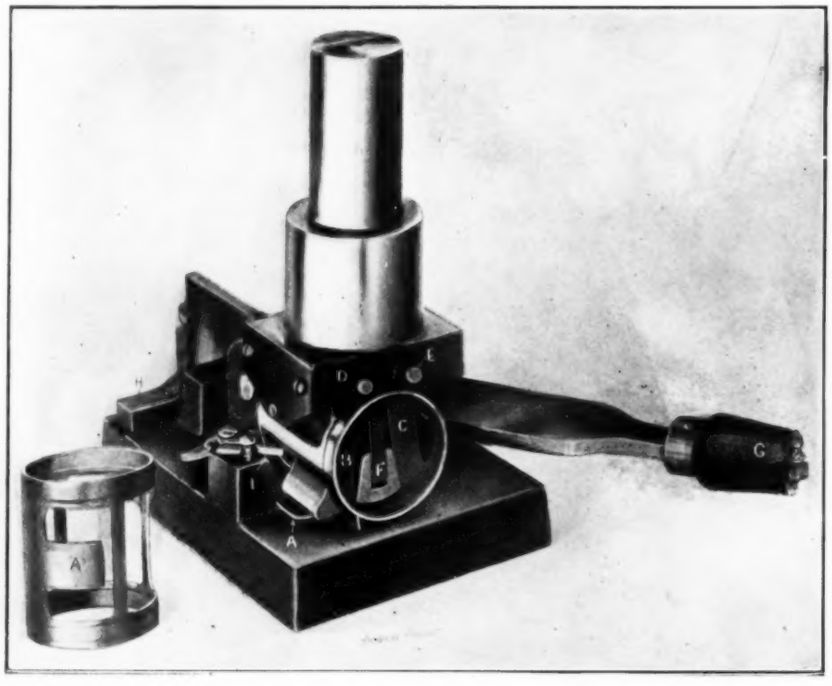


FIG. 4. EXPANDING THE WINGS OF THE REEL SEAT

The dies in Fig. 2 are so made as to allow for a trimming operation on the posts. This trimming operation is performed by the punch and die shown in Fig. 5. In this case the punch is underneath while the die straddles on top. To the left in this illustration is shown the blank with the wide post *A*, which is shown trimmed to size on the right at *B*. *C* and *D* are stops which index upon the edges of the holes. The lever *E* holds the blank up against the rear stops and supports the horn.

Fig. 6 shows the forming punch and die used for forming the wings to correct shape. The slot *A* accommodates the center post at the top of the reel body *C* and also locates it so as to be in alinement for the punch. The lower forming die *B* slides through the two openings in the body of the reel and is located by the set screw *D* at the left. The punch *E* is simple and needs no explanation. The blank has then reached the stage shown by *G*, Fig. 1. The threading shown at *H* Fig. 1, is done on a Fox lathe. At *I*, Fig. 1, the notches shown are made by a simple punch and die. They are for altering the position of the crank handle of the finished reel, which can be at will set in any one of four positions. Fig. 7 shows the operations on the reel ends. The plain cup *A* is beaded on top as shown at *B* in the sub-press die shown in Fig. 8. In this die there are two knockouts *A* and *B*, which are shown separated slightly for clearness. The piece *A*, Fig. 7, is placed over *A* and *B*, Fig. 8, and is forced by the plain punch *C* down into an annular groove in the die. This annular groove is of such depth that the edge of the blank *X* seats on the bottom of it. Any further pressure on the punch *C* compels the metal on the top to flow outward and form the bead. The two operations are shown at the right and left. The blank *D* for this operation is about 0.050 inch thick. After trimming it is 0.517 inch high and at *E* after beading it

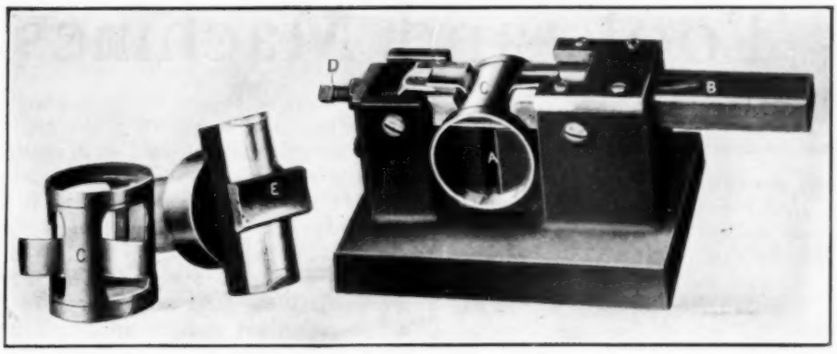


FIG. 6. FORMING THE REEL SEAT

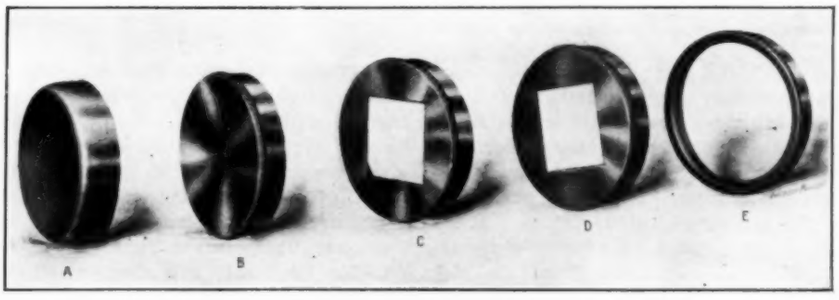


FIG. 7. THE OPERATIONS ON THE REEL ENDS

is 0.390 inch high. This beading leaves a slight groove on the inside of the piece which comes in handy as a starting place for the threading tool in the Fox lathe, the thread being cut from the inside outward. After beading the square hole is punched in the blank, this square hole being used as a driver, the chuck in the Fox lathe merely centering the piece lightly so as to avoid distorting it. After the threading and nurling operations the center is trimmed out in the lathe, leaving the completed end as shown at *E*, Fig. 7.

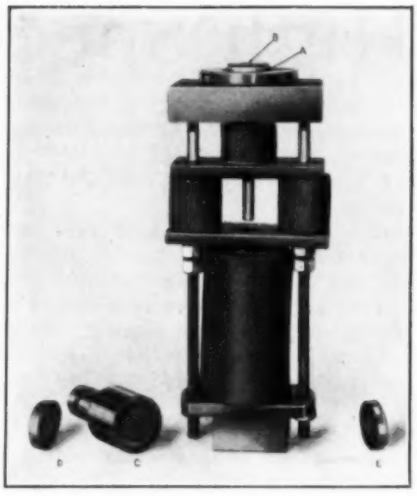


FIG. 8. THE BEADING DIE

Using Asbestos Over Again

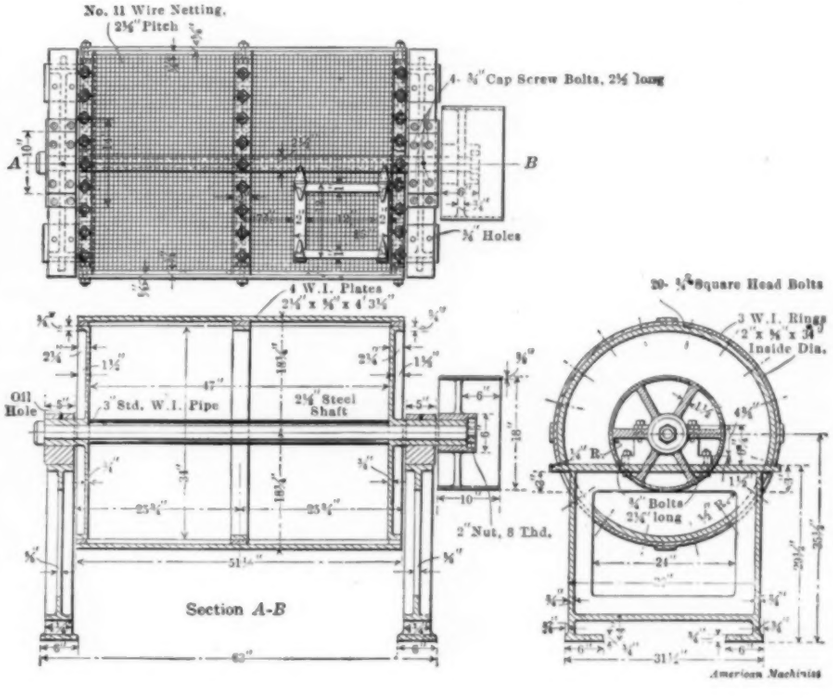
By I. B. Rich

It is the practice at the Beech Grove shops of the Big Four Railroad to utilize practically all of the asbestos jacketing that is taken from boilers and cylinders of engines undergoing repairs. If the pieces are at all broken (where blocks are used), as is usually the case, they are taken to the asbestos rattler as shown in the accompanying illustration, dumped in through the door and the rattler started up.

As it is driven by an 18-inch pulley having a 10-inch face, it is possible to apply all the power necessary and the pieces of asbestos covering are tumbled against the No. 11 wire netting with which it is lined, until they are broken up into such small particles that they can readily be used over again in the shape of asbestos plaster which can be applied for any kind of insulating work that may be desired.

This is one of the economies which were almost unknown in railroad shops of a decade ago and shows how the management of railway shops is getting nearer to the basis of manufacturing establishments than ever before. The design is so simple it can be readily made in any shop without calling very heavily on the purchasing department.

It is unnecessary to go into further details of description as the illustration gives all necessary dimensions to enable one of these to be built by anyone who desires to do so.


No. 11 Wire Netting, 2½" Pitch
4- ⅝" Cap Screw Bolts, 2½ long
A
B
¾" Holes
4 W.I. Plates 2½" x ⅜" x 4' 3½"
20- ⅝" Square Head Bolts
3 W.I. Rings 2" x ⅜" x 3' Inside Dia.
Oil Hole
3" Std. W.I. Pipe
2½" Steel Shaft
¾" Bolts 2½" long
2" Nut, 8 Thd.
Section A-B
American Machinist

RATTLER FOR BREAKING UP OLD ASBESTOS

High Speed Tools and Machines*

By H. I. Brackenbury

The advantages of high-speed steel tools over carbon-steel tools as shown by English practice. Older machines are often adaptable for the new steel because of their massive design. The trend of recent design particularly adapted for the requirements of modern speeds.

*Presented at joint meeting of the Institution of Mechanical Engineers and American Society of Mechanical Engineers. Condensed.

There are three classes of high-speed tool-steel, which will be called in this paper:

CLASS A.—For cutting mild and medium steel.

CLASS B—For cutting hard steel such as tires, etc.

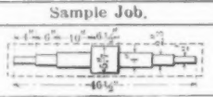
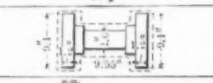
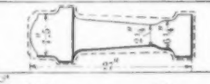
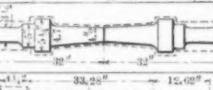
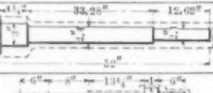
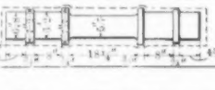
CLASS C.—For cutting very hard steel and for use in cases where a sharp and lasting cutting edge is required; especially useful in cases where deep cuts with fine feeds are used.

POWER REQUIRED TO REMOVE MATERIAL

More power is required to remove a thin wide chip than a chip of double the thickness and half the width; that is, to remove a chip 1 inch wide with a feed of 1/16 inch requires more power than to remove a chip ½ inch wide with a feed ⅛ inch. This is less noticeable with tools with sharp edges. Tools with blunt cutting angles require more power than tools with sharp cutting angles to remove the same amount of material, the objection to sharp cutting angles being that the edge is apt to break.

The total power used for a given cut, including the power absorbed by friction in the machine, increases at a smaller ratio than the increase in cutting speed; in other words, less horsepower is used per pound of material removed at high speeds than is used at low speeds. This is only true up to a certain point.

Apprentice Labor.

Sample Job.	Article	Mat.	Wages Rate	Actual Tm. Taken	Total Cost + Bonus	Feeds Revs	Remarks
	Shafts for Motor Gener'trs	Forge Steel	2¼ D. per Hour	From 1 Hour to 1½ Hours	From 2.8 D. to 4.2 D.	24/96	Parallel Forging Number of Diameters Vary.
	Middle Exten'n Shaft for Balancer	Forge Steel	Ditto.	3⅛ Hours	9.8 D.	16/30	Over 1" of Material to Turn off all over.
	Conn'ing Rod	Forge Steel	Ditto.	4½ Hours	12.6 D.	20/40	Excessive Amount of Material to Turn off.
	Wagon Axle	Forge Steel	Ditto.	6¾ Hours	17 D.	12/20	Rough Turn close to Finished Sizes and Finish Ends.
	Spindle	Forge Steel	Ditto.	1 40/60 Hours	4.6 D.	32/78	Rough Turn for Grinding 0.03" Left on
	Vertical Shaft	Forge Steel	Ditto.	1 20/60 Hours	3.7 D.	12/14	Rough Turn all over.
	Engine Axle	Forge Steel	Ditto.	5 40/60 Hours	15.9 D.	16/28	Forging Practically Parallel R. Turn & Face Ends

American Machinist

FIG. 1. EXAMPLES OF WORK ROUGH TURNED ON LATHES OVER 20 YEARS OLD

DIFFICULTY OF LAYING DOWN RULES FOR CUTTING SPEEDS

Figures of the speeds and feeds and depths of cuts which can be taken with lathe tools of high-speed steel under ideal conditions are interesting, and are very useful in showing in what direction we should modify our old methods and design new machines, and to what perfection we should strive; but the author does not think these figures are of much use as a guide to what is actually performed in the general run of workshops. There are so many variations in the actual conditions that, without a careful study of each class of case, it is difficult to say what is the best rate to cut at. Mr. Taylor, in his most valuable work, "The Art of Cutting Metals," gives 12 variable elements, but even this number does not cover the whole ground, and such questions occur as one man working several machines and several tools cutting simultaneously. Thus, on certain work where there is a large amount of repetition, it has been found possible to employ to advantage lathes with two saddles and three rests to turn work from 3 to 4 feet long. As one man looks after two of these lathes he has to keep six tools at work on very hard steel. It is quite evident that under these circumstances it is important that the tools should not require changing often, as this would cause the lathe to be idle for a portion of the time, and too much of the workman's energy would be used up in changing the tools and setting in the cuts. One of the advantages of the use of high-speed steel in the above case is that the tools will generally run for the day without requiring to be ground. This work could be done at higher cutting speeds using one tool and grinding more frequently; the result would be more effective to watch but less satisfactory to pay for.

CUTTING ANGLE

Regarding the question of cutting angles, careful experiments have shown that the sharper the angle is the less the amount of power required to remove a given amount of material, the feed and depth of cut remaining constant. On the other hand, the sharper the angle is the more likely is the cutting edge to crumble or break, and the smaller is the body of steel to conduct away the heat generated by cutting. In no well regulated machine shop do the workmen grind the tools they use; grinding machines with trained operators are now almost universally employed for this purpose.

VALUE OF STANDARD ANGLES

The importance of working to standard angles is obvious, and the fewer the standards the better, so long as the loss in cutting efficiency is not greater than the gain in grinding and forging tools to a small number of standards. The question of what standards are required must depend on the variety of work and material and quality of machines in a shop. The author strongly deprecates becoming a slave to standards when many variables are involved, and feels that it should be the duty of a capable shop manager or foreman to experiment with tools of various cutting angles when he has a suitable run of work.

IMPORTANCE OF CHANGING ANGLES AS QUALITY OF TOOL STEEL IMPROVES

High-speed steel has improved in the past few years and will probably improve in the future, and with these improvements we find the cutting edge remains sharper for a longer time and the cutting angles may be made more acute. As an instance, when turning axles at the most convenient feed and speed and depth of cut, the belt failed to drive the lathe when using the standard round-nose tool. A tool was ground with a smaller radius on the nose, a straighter cutting edge and a sharper angle; the belt was found to have sufficient power to drive the lathe with the full depth of cut when this tool was used, and the tool was adopted

as the standard for this particular work. The reasons for the above are: (*a*) The cutting length of the tool was diminished, less power being required to take a thick narrow chip than a thin wide chip; (*b*) The sharper angle presents less resistance to the chip after it is sheared from the body of the material. Such a tool would not have been suitable for the general practice of the shop where heavy feeds are used.

The following are the particulars of the case, and are interesting as showing what use can be made of high-speed steel even in an old machine, a question which will be dealt with further on:

Machine.	Age.	Material.
Lathe 15-inch center	Over 30 years	Axle Steel.—Breaking 38 tons per square inch. Elongation 24 per cent.

Tool No. 1.—Clearance 5 degrees, side slope 13 degrees, cutting angle 72 degrees.
Tool No. 2.—Clearance 5 degrees, side slope 25 degrees, cutting angle 60 degrees.
Speed 52 feet, feed 1/16, depth of cut ⅛ inch.
Cubic inches per minute removed, 19.5.
Pounds per minute removed, 5.5.

Use of High-speed Tool Steel on Turret Lathes

On turret lathes the highest class of high-speed steel is now largely used, and tools with a very sharp cutting angle are employed. A test, carried out at the works of Messrs. Alfred Herbert, gave the following result:

Tool.	Revolutions per Minute.	Cutting Speed, Feet per Minute.	Feed per Revolution, Inches.	Feed per Minute, Inches.	Weight Removed per Minute.
					Lb.
Carbon steel....	149	58.5	0.0134	2.010	0.753
Class C.—Special high-speed steel.....	470	185	0.05	23.5	8.8125

Tool-clearance angle, 7 degrees. Side slope, 35 degrees. Cutting angle, 48 degrees.

REDUCING A MILD-STEEL BAR FROM 1½ INCHES TO ¾ INCH DIAMETER AT ONE CUT.

Economy in Power

The pressure of the chip on the tool in tons per square inch, cutting on steel of a tensile strength of 25 tons and 44 per cent. elongation, was 75 tons, which is about 25 per cent. less than results given with tools of which the cutting angles range from 65 to 70 degrees; part of this reduction was probably due to the keen cutting edge which this special high-speed steel maintains. The whole of the tests worked out as follows, omitting one exceptional case:

Tests.	Horsepower.	Pounds per Minute Removed.	Pounds per Horsepower Minute.
Tests made, 1909.			
Highest figure...	14.4	7.58	0.52
Lowest figure....	6.1	2.01	0.33
Manchester experiments, 1903.			
Highest figure...	8.94	4.41	0.49
Lowest figure....	17.19	5.6	0.32

The 1903 figures represent net horsepower at the tool, but the 1909 figures include all losses in the machine.

Twist Drills

Perhaps the most striking instance of the value of high-speed steel is given by the use of twist drills. The improvement obtained by the use of this steel for drills is more easily grasped than in the case of turning tools, as there are far fewer variables. Given sufficient power, a high-speed drill does three times the amount of work and requires grinding less frequently than the temper-steel drills. The author is not one to advocate the policy of scrapping all old material, but in the case of twist drills, where any quantity of work is required to be done on steel, he advises the use of nothing but high-speed steel drills.

One instance is given here, namely, a drill ¾ inch diameter passing through a cast-iron block 2½ inches thick in 8 seconds, which is equal to a travel of 18¾ inches a minute.

Full Advantage Not Yet Taken of High-speed Tool Steel

Although considerable use is made of high-speed steel in engineering workshops, the author ventures to say that, generally, full advantage is not taken of its cutting powers. Certainly speeds have been greatly increased, but they have not been increased in the proportion warranted. No doubt valuable economy has been effected by the increased speeds, and the length of time tools run without the need of grinding. We should not content ourselves with these results, but strive to use to the full the powers which the steelmakers have put in our hands.

Savings Which Can Be Made

The author thinks that, although the rapidity of production with high-speed tools has been well emphasized during the last few years, insufficient attention has been given to the accompanying savings. Where full use is made of modern machinery the production, in so far as roughing-out goes, is three times what it was under the old conditions. This means that only one-third the number of machines, one-third the amount of space, one-third the number of operators, one-third the amount of shafting and about one-half the amount of supervision are required to produce the same amount of work. Further, although the power required to drive machines capable of making full use of high-speed steel is very large, the power absorbed for each pound of metal removed is less for high-speed than for low-speed machines.

Machines for Roughing Out

There is, in the author's opinion, only one way in which the full saving may be made, and that is by setting aside certain machines for roughing and roughing only. It is quite unnecessary to replace all or even many of the old machines, which have quite enough power to carry the finishing cuts at good speeds, nor is it desirable to use either the same class of machinery or labor for roughing out as for finishing.

Use of Old Machines for High Speed

There are a number of workshops where there is not the inclination or, owing to trade depression, the capital to buy many new machines. In such cases much may be done by making a judicious selection of the heaviest of the existing machines and increasing their belt speed, so that high speeds may be run with the back gear in. In some instances, the cones have been removed and replaced by wide pulleys, speed changes being provided for by means of sliding gears. Fortunately the English machine builders of the past did not hesitate to put plenty of weight into their machines, so that, by increasing the driving power, excellent results may be obtained, but it is generally necessary to fit new gears. Fig. 1 shows an account of work produced by the above method by machines over twenty years old.

General Remarks on Machines Fit for the Use of High-speed Steel

An idea of what saving in cutting time has been made by the use of high-speed steel can be gathered by the comparison of the power allowed for machines designed before and after its introduction. Engineers have also grasped the fact that the power which may be usefully employed depends upon the stiffness of the work and not on the hight of centers in the case of lathes or the length of stroke, etc., in the case of other machines. Thus we find instances of 12-inch center lathes designed to use 50 horsepower, which is about 10 times as much power as was allowed for in any of the pre-high-speed lathes. This increase in power must be accounted for by a desire for increased depths of cut and feeds as well as increased speeds. There is no doubt that the interest awakened by the introduction of high-speed tool steel has called so much attention to the subject of roughing out work that many improvements have lately been made which might have been made in earlier times. The author well remembers cases where recourse was had to putting three belts, one

on the top of the other, to increase the very limited belt power of some lathes.

The following are some examples of increases in horsepower provided:

Machines.	H.P.
Turret lathe for 2¼-inch bars increased from	2 to 10
Lathe, 6-inch center, increased from	1 to 4
Lathe, 10-inch center, increased from	2½ to 10
Lathe, 14-inch center, increased from	5 to 20
Lathe, 36-inch center, increased from	20 to 60
Lathe, 60-inch center, increased from	30 to 100
Slotting machine, 12-inch stroke, increased from	9 to 15

Special cases of high power are:
12-inch center lathe, 50 horsepower.
18-inch center lathe, 60 horsepower.

The 18-inch center lathe took a test cut on steel 1½ inches deep with a ¼-inch feed, at a cutting speed of 28 feet per minute, the consumption of power being upward of 80 horsepower.

Limit of Power Applied

There seems to be no finality as to the amount of power which can be applied to a machine. We find a milling machine described as capable of removing 1400 pounds of steel per hour which would entail a consumption of not less than 92 horsepower. Such a machine may be economical when it can be employed on a continual run of work requiring such cuts, but would be a serious charge when employed on lighter cuts. In the desire for rapid production from machines we must be careful not to overlook the consideration of the cost of power and value of material cut to waste in cases where the work could be made nearer to the size in a more economical way. The fact that by the use of high-speed machines a ton of cuttings can be made at a labor cost of 8d. (16 cents) must not make us forget that someone has to pay for a ton of material and 7s. or 8s. ($1.75 to $2) for power.

Laws Regarding Limit of Weight and Power of Machines

It is impossible to lay down any law regarding the limiting point of the weight and power of machines, as the number of variables which enter into consideration is so numerous. There are, however, three principal governing factors, namely:

(1) The length of time the machine will be used for heavy cutting.

(2) The length of time the machine will be used for light cutting.

(3) The length of time the machine will be at rest.

During (1) the machine is used efficiently; during (2) more is being paid for power and capital charges than if a lighter machine were used; during (3) more is paid for charges than in the case of a lighter machine.

These considerations evidently point to the importance of using heavy machines for roughing only, but there are many cases where this cannot be done. Take, for instance, the case of a drilling machine which is generally employed to drill and ream holes of an inch in diameter, but occasionally has to drill holes 3 inches in diameter. In such a case it would be a mistake to install a machine capable of drilling the 3-inch holes at a quick rate, as the proportion of standing to working time is very large for a drilling machine, and the time during which the machine would be employed at its full power would be very small.

Objections to Stepped Cone

The stepped cone is rapidly becoming obsolete, except in the case of small machines. The obvious disadvantages of this method of changing speed are the trouble, and, in the case of boys, the danger of throwing a heavy high-speed belt from one step to another and the variation in power available from the different belt speeds.

Speed changes are provided for by means of sliding gears in the case of medium-sized machines and variable-speed motors in the case of larger machines. Such motors, worked on the direct-current three-wire system, give a large range of speed which is excellent, but it is well to notice that at certain speeds with light cuts the efficiency of motor and machine may be far from good.

It appears that heavy lathes which are required to do both light and heavy turning should have the gear ratio arranged so that the full range of speed may be obtained from either voltage, and that builders of such heavy machines should give the total efficiency of the lathe and motor at various speeds and loads. No engineer would purchase a power-generating plant without obtaining a guarantee of its efficiency at various loads, and there seems to be no reason why less care should be given to the efficiency of plant using the power. It is true that the expenditure on power is in most cases only a small portion of the total expenditure, but when the total expenditure is large, the small portion becomes quite large enough to trouble about.

Helical Gears

The gears which are always in mesh should have helical teeth to insure quiet and smooth running and to prevent chatter. The pinions should be hardened and, of course, all wheels should be made either of forged steel or steel castings.

It is of great importance to cut the teeth of gear wheels to a considerable degree of accuracy. Some idea of what vibration may be set up by inaccurate teeth is given by the following instance. Two teeth having broken out of a gear wheel on a large lathe they were replaced as a temporary measure by pegs filed to shape according to the usual millwright method. The result was apparently satisfactory on low speeds, but a very unpleasant vibration was set up at higher speeds. A diagram plotted from the movement of the ammeter needle showed a considerable wave of current at low speeds. This wave took place after the peg teeth had passed out of gear, and was evidently due to the power required to regain velocity which had been lost when the peg teeth were in gear. Anyone who has had to cut gears for motor cars knows how much noise and vibration may be set up by a very slight inaccuracy in the pitch or form of the teeth.

Worm and worm wheels should never be used unless hardened. The author has seen the teeth of a cast-iron worm wheel 7 feet in diameter almost entirely worn away in a few days; the introduction of high-speed steel has meant the replacing of many worm and worm-wheel drives by spur-gear drives.

All feed arrangements must be amply strong, as in certain cases the side pressure is equal to the vertical pressure on the tool.

Lathes Especially for Roughing

Very powerful machines are now built for taking heavy cuts. The beds are made very wide to give ample support and bearing surface for the saddle, and the spindles are made of what appears to be excessive strength, but it is most important to have ample bearing surface and an absolutely rigid spindle to prevent chatter. A general rule is to make the diameter of the front bearing half the hight of the center:

Thus a 6-inch center lathe would have a 3-inch front bearing.
Thus a 12-inch center lathe would have a 6-inch front bearing.
Thus a 14-inch center lathe would have a 7-inch front bearing.

There should always be a hole through the spindle, as this is required for the bolt for drawing up expanding chucks or for supporting the end of a boring bar.

The tailstock should be very massive and clamped to the bed by two bolts in the case of the smaller sizes, and three bolts for larger sizes; the diameter of the barrel should be one-third the hight of centers.

A 14¼-inch lathe made in 1910 to replace the former lathe for roughing purposes was designed for turning nickel-chrome steel and to stand very rough usage, and was therefore made as simple as possible with the further advantage of being inexpensive. The thrust on the spindle was taken up by the ball bearing, one of the tests of the lathe being to screw up the back center with a lever 4 feet long with a pull of 560 pounds at the end. The driving pulley was turned round by hand with ease when the resulting pressure was on the spindle. Two saddles and three rests are provided, each saddle having its own lead screw, so that one saddle can be run in a differ-

ent direction and feed to the other. The nuts, 9 inches long, are of cast iron. It is interesting to read in the specifications of the lathes built in 1899 that they have been designed on exceptionally powerful lines to permit of very heavy cuts being taken.

A lathe for turning straight axles up to 12 inches diameter was required to carry a test cut of two tools, each cut ⅜ inch deep, 1/7 inch feed at 50 feet per minute cutting speed, on 35-ton steel, motor 36 horsepower.

One maker of lathes provides an arrangement of expanding cones with a belt driving by its beveled edges, and by this means any speed between the highest and lowest can be obtained. When applied to a cutting-off machine, arrangements are made so that the speed automatically increases as the diameter being cut diminishes.

Turret Lathes

Turret lathes have been greatly strengthened, and one capable of dealing with bar up to 2¼ inches in diameter can reduce a bar from 2¼ inches to 1 inch diameter at a traverse of 11⅜ inches per minute with an expenditure of 20.7 horsepower, when using the latest form of high-speed tool steel (Class C). The ordinary steadies were found quite useless at this high duty, and a roller steady has been introduced with excellent results. Such a machine fitted with a roller steady averages an output at least 33 per cent. greater than the output of the older machines designed for the use of ordinary high-speed steel, and at least 100 per cent. more than the pre-high-speed tool machines, so that the extra cost of the modern machines is small compared to the saving. Of course, such cuts as given above are not often required, so that a provision of 10 horsepower is quite sufficient for all ordinary purposes.

Size of Machine.	Strokes per Minute.	Cut in Inches.		Feed.	Superficial Area Covered per Minute.	Material Removed per Minute.
		Length.	Depth.			
Inches.					Square Inches.	Pounds.
10	45	10	⅛	1/10	22.5	4
6	65	6	⅛	1/10	19.5	2

Slotting Machines

Little attention has been called to the adaptation of slotting machines for the use of high-speed steel, so that the cutting powers on steel for two machines of modern design, given in the above table, will be of interest.

The cuts were taken without the least sign of jar or vibration.

Jib-drilling Machines

Great attention is now paid to making these machines so stiff that very little deflection of the saddle takes place. One maker provides a double-girder jib with a space left between the two girders for the saddle. The saddle is supported by the girders on each side of the spindle, so that there is no twisting movement round the horizontal axis of the jib. Change-speed gear boxes or variable-speed motors are generally provided, allowing from 12 to 15 horsepower for the larger sizes. Such machines are capable of drilling inch holes at a rate of travel of 5 inches a minute, and to drill 100 inch holes in an hour through plates an inch in thickness is ordinary practice.

Really fast drilling cannot be done on old jib-drilling machines, as the jibs spring and twist, causing the drills to break, and in many cases the arrangements for feeding and withdrawing the spindle are most unsatisfactory, but still high-speed drills can be used to considerable advantage in some of the best makes of pre-high-speed drilling machines by increasing the belt speed. But running the drill at a high speed and a fine feed entails considerable loss of power.

Milling Machines

The power allowed for milling machines has been greatly increased within the last few years, but it is very doubtful if milling machines should be used, except in special cases, for heavy roughing work, as the power required to remove material with a milling cutter is very large as compared to tools of the lathe type. The milling cutter may be compared to the lathe tool with a very long cutting edge removing a thin wide chip, which, as has already been seen, requires far more power than a tool with a short cutting edge removing a thin narrow chip. The actual consumption of power to remove a pound of material with a milling cutter is about double that required by a lathe tool.

Planing Machines

A great advance has been made in the cutting speed of planing machines, and naturally with the increase in cutting speed came a desire for a quicker return stroke. Heavy planing machines now have a return-stroke speed of 90 feet per minute and lighter machines are made with a return stroke up to 180 feet per minute, the shock and the reverse being absorbed by recoil springs. Various devices are now made which can be fitted to pre-high-speed planing machines by means of which the above results may be obtained at a moderate expenditure of money, and the results are most satisfactory. It seems a pity that more use has not been made of the arrangement fitted to the planing machines designed by Sir Joseph Whitworth for cutting on both strokes; certainly for roughing out this is very economical.

Clean Out the Oil Holes

When assembling new machinery, the importance of thoroughly cleaning all the oil holes and passages is frequently overlooked. In many instances, the workman does not realize the imperative necessity for great care in this direction and he gives little attention to the oil passages save to see that they exist. The erecting machinist would do well to take nothing for granted in relation to new machinery, but to see for himself that things are as they should be.

An experimental machine was being erected and necessarily, a good deal of "try-it-out" work was being done. The force of circumstances made it necessary to do the necessary erection work with a bright young man, who, though willing, was entirely inexperienced in the assembling of machinery. He did his work as well as could be desired, but did not realize the necessity of continually watching out for grit in the several bearings of the machine under construction.

The peculiar service to be performed by the machine in question made it necessary to lubricate by means of compression grease cups and usually the cups were tapped into the end of the bearings which they were to lubricate. Before the new machine had run an hour it began to develop signs of distress in several bearings, and a shut-down was found to be immediately necessary. After overhauling several bearings they were found to contain chips and filings which had become imbedded in the surfaces of the bearings, to their great detriment.

The bearings were cleaned and made up again, only to be soon "stuck on themselves" with more grit and filings. This time the oil holes were all cleaned out and washed thoroughly with naphtha, after which a most interesting collection of metal chips, sand and dirt was found in the bottom of the gasolene. But even the thorough cleaning of the oil holes did not prove sufficient, for more trouble followed another start of the machine, and this time it was found that the cup grease was impregnated with grit, the barrel containing it having been left uncovered through several dust storms. The grease was melted, strained and the cups again filled with pure grease after another thorough cleaning out. This time there was no more trouble with bearings.

The incident, as stated, adds to the evidence that great care is necessary in setting up work, to see that there is no dirt left in oil channels to give trouble afterward.

Two Remarkable Old English Clocks

By F. A. Halsey

Timepieces which have ticked out the hours for nearly six hundred years and one of which is still at work.

In 1903 W. H. Booth contributed to the AMERICAN MACHINIST a description of two old clocks then and now on exhibition at the South Kensington museum. At that time, and, in fact, until recently, the clocks had not been photographed, but that having now been done, the possibility of showing illustrations of them for the first time justifies the telling of the story of the old machines again.

THE GLASTONBURY ABBEY CLOCK

Fig. 1 shows the older of the two, known as the Glastonbury Abbey clock, for which abbey it was made by a monk named Peter Lightfoot in the year 1325. During the reign of Queen Elizabeth it was removed to Wells cathedral, where it continued at work until about 1835, at which time, because of the wear of its parts, it was removed to the crypt and its place taken by a new movement. From this place it was subsequently removed to the museum where it now stands, as a loan exhibit from the cathedral, and where, with a few restorations, though without a dial, it is kept constantly in motion.

The restorations consist of the brass bevel gears in front of the frame and connecting the main train with the dial mechanism, the making of these parts having been necessitated by the fact that the corresponding old parts were lost. The losing of these parts is easily understood when we consider that in their original location the dial movement and the main frame were naturally separated by a considerable distance, and when the clock was removed to the crypt they were necessarily detached from the other portions of the movement. We may, in fact,

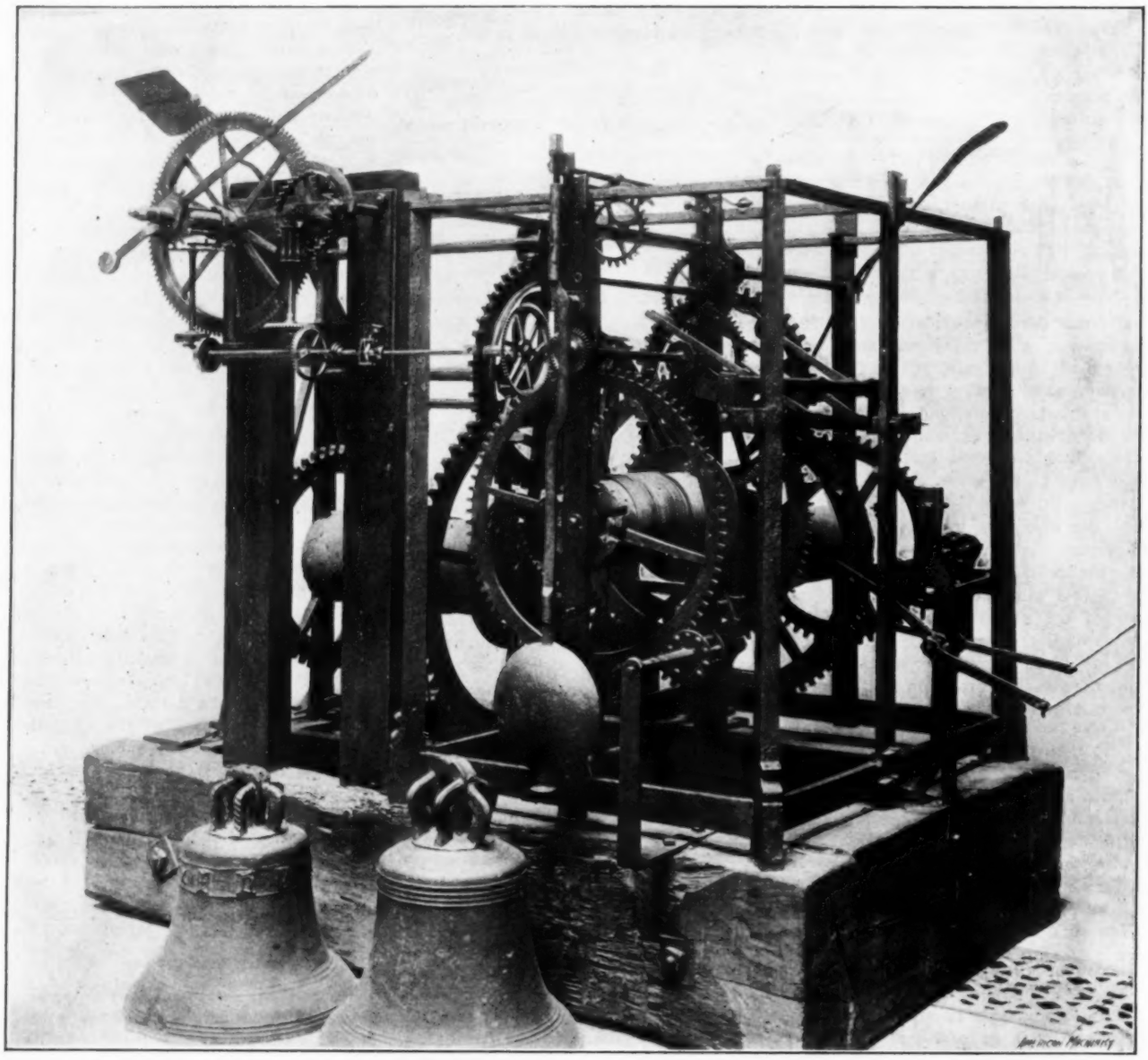


FIG. 1. THE GLASTONBURY ABBEY CLOCK, DATING FROM 1325

be very thankful that the dial mechanism did not suffer the same fate.

In another respect, however, the clock now differs from its original form. It antedates the invention of the pendulum and hence could not have been originally fitted with that feature. It was, no doubt, originally fitted with the verge escapement, of which an example is shown in Fig. 2, although of the date when the pendulum was substituted there is no record.

The first published description of the pendulum by Galileo appeared in 1637.

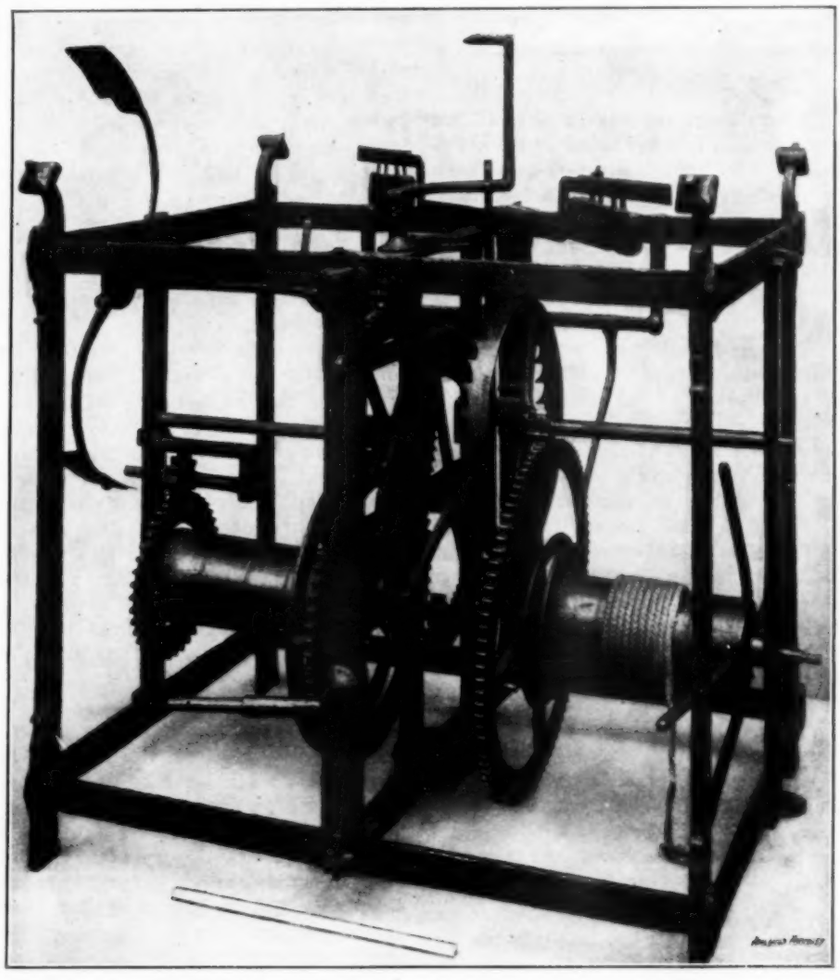


FIG. 2. THE DOVER CASTLE CLOCK, DATING FROM 1348

An idea of the size of the movement may be gathered from the fact that the pendulum beats seconds and its length to the center of oscillation is thus a little over 39 inches.

The clock is undoubtedly the finest example of medieval English horological work that exists. It strikes the hours and quarters on different bells, the sound of which rings through the museum at appropriate intervals. Moreover, in addition to the time of day, it indicated the age and phases of the moon, although, having no dial, it does not now do this.

The striking mechanism is of the type now commonly used in American clocks. The driving of the hands will be seen to be by an entirely different mechanism from that now used, each hand having an independent train from the horizontal shaft which drives both.

THE DOVER CASTLE CLOCK

The second clock, known as the Dover Castle clock, is shown in Fig. 2. It was made in Switzerland and dates from 1348. It has the verge escapement, as plainly shown in the picture, this being, so far as we know, the earliest form of clock escapement. The horizontal notched bar, which carries the balance weights, has a length of about two feet, the regulation having been accomplished by shifting the weights along this bar. The picture shows the very natural origin of the term balance, which we still have with us, although with little of its original significance. The spindle which carries the balance arm has a hole near its upper end, from which, in use, it was suspended from the bar above it by means of a string, which thus released the step from the weight of the parts and, by reducing the friction, must have improved the time-keeping qualities of the clock. This string does not appear in the picture.

The escape-wheel pinion is driven directly from the wheel on the driving drum, the short train obviously requiring a very long rope or very frequent winding. The barrel is loose on the shaft and instead of the present ratchet and pawl construction a spring clip is so arranged as to engage with the spokes of the wheel.

Both clocks are entirely of wrougnt iron, the rims and spiders of the wheels being made of separate pieces which are riveted together. The frame members are held together by a mortise, tenon and key construction, which is best shown in the picture of the Dover Castle clock.

It is quite probable that the Glastonbury Abbey clock is the oldest piece of machinery which is still at work, although its interest is somewhat lessened by the changes to which it has been subjected. It certainly gives one pause to reflect that this machine had been marking the lapse of time for 451 years, when the United States became a nation, and for 167 years when Columbus discovered America.

Against the claim for the Glastonbury Abbey clock as the oldest piece of going machinery extant, the Dover Castle clock may with equal probability be claimed to be the oldest piece of machinery which still exists in its original form. Although not actually in motion, it is in going condition and could easily be set at work if desired. In point of merit it is, of course, far surpassed by the Glastonbury Abbey clock.

Machinery Trade in Japan in 1909

The British Commercial Attaché in Yokohama, Japan, has submitted to his government a report on the trade in Japan for 1909, from which it is interesting to note that the imports of machinery into Japan in the year 1909 were $7,130,500 (or 40 per cent.) less than the year before. The reduction in the United Kingdom's share was $3,307,000, or 32 per cent., while in the case of the United States and Germany it was $2,668,500, or 58 per cent., and $1,003,000, or 44 per cent., respectively.

The reasons for this decline are not far to seek, says the British Attaché. The Government's policy of cutting down expenditure wherever possible had a serious effect on business in machinery, but a still more potent factor was the stagnation in the industrial world. During the boom years of 1906 and 1907 many orders for machinery were placed which were only executed in 1908, but after the slump very little new business was put through. Had it not been for the extensive importations of machinery by the Japan Steel Foundry, at Muroran, which amounted to nearly $1,900,000, the 1909 total would have been much smaller.

Progress at Worcester Trade School

By E. H. Fish *

What has been accomplished in one year's operation.

Various school problems and how they have been met.

A school in which practical and commercial conditions are not lost sight of.

*Manager, Worcester Trade School.

A number of the readers of the AMERICAN MACHINIST have asked me recently what has become of the Worcester Trade School. We have been rather quiet lately so far as outward manifestation is concerned, but inside we have had a great deal to do and comparatively little time in which to do it. In a year's time we have built a building, equipped it and run six months. In that time we have taken in two classes and admitted a third to begin in September. The first class had 52 members, of whom 6 have left. The second class had 34 members, of whom 5 have left, leaving 75 now in school. Thirty have been admitted to enter in September, which, with the probable falling off through the summer, will give us a school of about 100 day pupils.

WOOD WORK MORE POPULAR THAN IRON WORK

There is an even division between wood workers and iron workers, which is due to our being limited in our capacity in the wood shop. We have had from two to three times as many applicants for wood as for iron work, for which we are sorry, inasmuch as the demand for workmen in the machine shops here is greatly in excess of that for pattern and cabinet makers.

Two reasons for this tendency of the boys to flock into the wood shop are apparent, one, because they have nearly all had more or less manual training in the public schools, which give no metal work, consequently the boys have no idea as to whether they would like it or not; the other, that every dub of a wood worker in the city gets $21 per week for 48 hours' work, while there are very few skilled metal workers who get as much as that for 56 hours. No comment is necessary other than to say that all the facilities we can offer will not appeal to a boy alongside of dollars and cents.

I can truthfully say, however, that if these boys stay with us the four years, and if they continue to improve as fast through the remainder of the course as they have so far, they will be able to command wages soon after they leave us that will make the wood workers envious.

SOME GENERAL RESULTS

I can imagine all my friends holding up their hands in holy horror at these statements, but, sanguine and visionary as both Mr. Higgins and myself have been in print in the past, the results so far developed have surpassed our greatest hopes. The boys are getting able to understand and obey orders. A few of them are even beginning to think for themselves.

When I say that these boys are doing well I hope your readers will realize that all of our instructors, except myself, are practical men in every sense of the word. That is, the other instructors have been in the shops and shops alone for years. They have no basis of comparison with other schools, as I have, but their comparison is with other shops. Yet they all agree that these boys are progressing faster than they would if working full time in any commercial shop, though for that matter ours is a commercial shop in every sense of the word.

Not more than 1 per cent. of the entire shop time of the boys has been spent on work which was not intended for use either as equipment for ourselves or for sale. About 6 per cent. of the boys' work has been spoiled in the machine shop, and about 10 or 15 per cent. in the wood shop. This is easily accounted for on the same basis as the fact that we have had two to three times as many accidents in the wood shop as in the machine shop. A slip may easily cost more on a piece of wood than on iron.

We are doing practically all our machine work to micrometer measurements, which, of course, makes it a much easier matter to get good work and also develops in the boys an idea of the degree of accuracy to which they can really work.

DIVISION OF THE SHOP TIME

Our equipment is proportioned to give the boys the following division of time: 15 per cent. on planer and shaper; 15 per cent. on millers and gear cutter; 10 per cent. on grinders; 10 per cent. on drills; 50 per cent. on lathes. This is our basis, but we recognize that most boys need more than their given percentage of time on the first tool on which they start, with the possible exception of the drills. That is, the boys have to learn dexterity on the first machine and to get into the swing of the shop.

THE WORK DONE

To get started, we took in a considerable amount of work from local shops, on which certain operations were to be carried out, but with only individual pieces to be made and with no opportunity to see where they went in the completed machine. This was done in order to get work suited to green boys without tying up money in work under way. We are now getting away from this idea as rapidly as possible, because we feel that the boys learn much faster if they see their work put together and the machine grow under their hands. To this end we built a lot of patternmakers' vises for our own use. These gave us good planer work, in fact, better planer work than was really needed to make a good pattern vise; they gave us work on the lathe, including the cutting of square threads, drilling and also babbitting, for we babbitted the nuts. We shall likely be on the market another year with a really good pattern vise, one that is simple and thoroughly well made. The price may be a little high, but the vise will be worth it.

We have built two lots of tool posts complete for one of the local lathe builders. With the slot to be worked out and the screw to be fitted and head milled, these have given us a much needed variety of work.

Perhaps the best job that we have taken has been a dozen 11-inch double backgeared lathes for one of the local manufacturers. These are half done now and sufficiently far along so that there is no question of our ability to finish them in more than creditable shape and also with creditable speed.

COST AND REVENUE

We are keeping close tabs on our boys' time. All work is done on requisitions, duplicates of which are kept in the office. Each boy enters his time on each job on a time ticket every day. On this ticket he enters the number of the requisition on which he is working, the name of the part and the time spent on the various operations, planing, milling, turning, etc. These tickets are collected and turned in to the office every morning by the boy who looks after the tool room. Here they are looked over to see that they are properly made out and sorted according to requisition numbers. Then the total time on each requisition is entered on the back of the office copy of that requisition. When the job is complete, the shop instructor turns in his copy of the requisition and the job is billed at whatever price had been previously agreed, or, if it is a requisition for equipment, it is entered as a part of our assets at a value that is conservative. The net income per boy hour is also noted on the requisition card.

Our aim is to make the average rate entered on these cards come as near the

average cost of maintaining the school as possible. Our cost of maintenance has steadily decreased from 30 cents per boy per shop hour to about 15 cents, at which point it will probably stay for some time. Our revenue from boys' work has varied from 2 cents per hour to about 25 cents. The average revenue has been less in the wood shop than in the machine shop, owing to the larger proportion of hand work and the greater liability to spoiled work. On the other hand, the cost has been less, due to the fact that one instructor can handle a larger number of boys than in the machine shop.

It seems to be necessary to have about one instructor to each eight boys. As likely as not we may be able to increase the number of boys per instructor as time goes on. We do not believe in having one boy show another about his work unless the first boy really knows what he is doing. We have been able to get a little help in this way, but do not expect to be able to get much good from it for another year.

The cost of materials, which was expected to be one of our heavy expenses, has really been very light. Of course, cost of materials used in building equipment has been met out of our appropriation for equipment. Work done for outside parties has been done on materials furnished by them. So far we have finished nothing for the open market. We have a few hundred toolmakers' clamps in process, but the entire investment for material has not exceeded $50.

The Matter of Discipline

The question is often asked: "How do your instructors get along at teaching?" Our instructors being all practical men with no previous experience in this kind of work, this is a very natural question and one that, for the benefit of other cities, should be answered frankly.

One difficulty presented itself at the start and that was that these men did not easily comprehend what was necessary to be done to maintain discipline. This difficulty is likely to arise anywhere and any time under similar conditions. It ceased with us as soon as the men became aware that each individual must do his part. Of course, a few boys drifted in, in spite of our vigilance, who were hopeless, boys whose parents had tried to do everything for and with them and who were brought to us as a last resort. Beware of the parent who is too anxious to get his boy into school. This kind of boy can stir up more mischief than a dozen earnest ones can counteract.

Other than this matter of discipline, which has taken our instructors from two to five months each to learn, I can say that there has been no difficulty. It should be borne in mind, however, that these men have all been foremen or superintendents before coming to us. That is, they have proved executive ability to some extent. What difficulties might have arisen if we had taken our men from the rank and file of shop men, I do not know. I suspect they would have been many.

We started with a little less than no time to settle on a policy or to arrange logical ways of carrying on our work. Possibly this was fortunate, as it compelled giving individual instruction to the boys rather than class instruction. As a result, each boy has been studied as a separate proposition.

The Class-room Work

In the class room, which so far has been devoted to English, arithmetic, algebra, history, drawing and shop instruction, we endeavor to make our work as individual as possible. To that end we are getting out our problems on tracing paper, 4½x6-inch size, from which we print about a half dozen copies. These problems we distribute to the boys as their needs seem to show. A boy who is slow can in that way take the necessary time and the boy who is quick can be kept profitably busy. We are working up the same thing in drawing. We have no textbooks, but rely on instruction by word of mouth and illustration on the board.

The work in English would be of little interest to your readers beyond the weekly shop reports which the boys write and in which we are endeavoring to have them show us whether they really understand what they are doing well enough to describe it. As would be expected, we are able to nail a great many misapprehensions and errors in nomenclature by this means.

Where the Boys Come from

It may be safely said that our experience shows that there is little class feeling about the school. Our boys are necessarily from families where the parents are in a financial condition to carry them along for the term, but we know that some are making a decided sacrifice to do it. A map of the city with a red dot where each boy lives shows a surprisingly even distribution. There is no class distinction in the school. The boys, on the average, are taking more care of their personal appearance now than when they first came. While we do not want and do not get boys who are afraid of dirt, we do feel pleased that they should go from us looking as a machinist should, as if he was proud of his calling. Comparatively few boys are following in their father's footsteps. Most of them are sons of men who are not working at a trade at all.

Most of them are boys to whom an income of $3 per day looks large. We have a few who might possibly have tried to go to a technical school if their parents felt equal to the expense, but I doubt if many of them could graduate.

Taken all in all, we seem so far to have started on the right road. We are in a position to agree with those who claim that a trade is best learned in a commercial shop, for ours is a commercial shop. We are also in a position to agree with those who believe in the half-time plan, for ours is a half-time plan; but we control both halves of the time.

Taking Down a Milling Machine

Sometimes when occasion arises to take down a large milling machine, considerable trouble is met with in starting the larger gears from their bearings upon the spindle of the machine. When a large gear is screwed in place with as good a fit as should be given to such work, and especially after the machine has been in use for a couple of years, it is quite a job to start the gears from their hold upon the shaft.

The round bar, 30 or more inches in length, usually supplied for starting these gears, has a couple of pins inserted in one side, these pins being fitted to engage in holes in the face of the gear. But with this wrench, it is usually a big problem to start the thread and the expedient is usually resorted to of having one man hold the wrench in position against the face of the gear while two other men, each with a 30-pound block of wood, strike together upon opposite ends of the wrench in a direction to start the thread. Unless the blows are struck at exactly the same instant, the two are little better than one single blow and the wrench, gear, and shaft yield so much that most of the force is lost before it reaches the thread to be loosened.

A good way is to attach a light rope or chain hoist to one end of the gear wrench. A steady strain is then taken on the hoist. With this tension on the wrench, a very few blows usually serve to start the thread, after which it is easily unscrewed with the wrench alone.

Sometimes it is possible to carry a rope from the overhead crane directly to the wrench. Again a snatch block may have to be hung up to give the rope the proper direction. Sometimes it is possible to pass the rope around some portion of a heavy machine, and let the rope slide theron in place of using a snatch block. When there is no overhead crane, or any rope or chain tackle, the rope attached to the wrench may be given two or three turns around a slow-running shaft, and by tightening the free end of the rope while held in the hand, the required wrench tension may be obtained.

Making a Warner Auto Meter

By Fred H. Colvin

Interesting operations followed in making a self-cleaning gear which drives the flexible shaft leading to the auto meter.

Some heavy punch and die work and a special forming fixture on a precision lathe.

The making of the Warner auto-meter which is a modification of the well known cut meter used in many shops to determine cutting speeds, involves fairly heavy die work and extremely light work which can be very well compared to the adjusting of the hair spring of a watch.

One of the interesting jobs of the heavy work is the making of their self-cleaning gear which drives the flexible shaft leading to the auto-meter itself.

The four stages through which this passes are shown in Fig. 1, the first operation being the blanking and cupping as shown to the upper left. This blank is next curled over as shown to the right by another die, while the third operation rolls the edge down as shown in the lower left-hand corner. The die in which this is done is shown in Fig. 2, and as will be seen, it has a center or supporting piece which limits the flattening done by the die. This inside support is made in sections so that it can be easily removed.

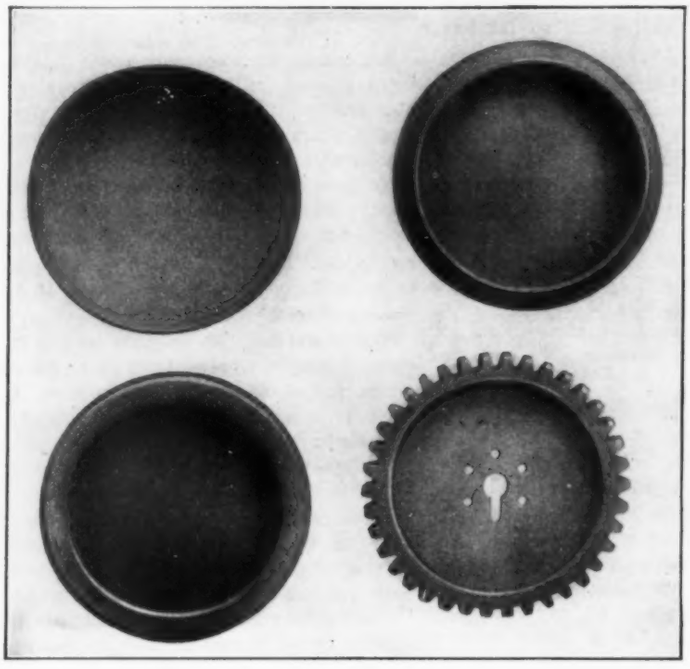
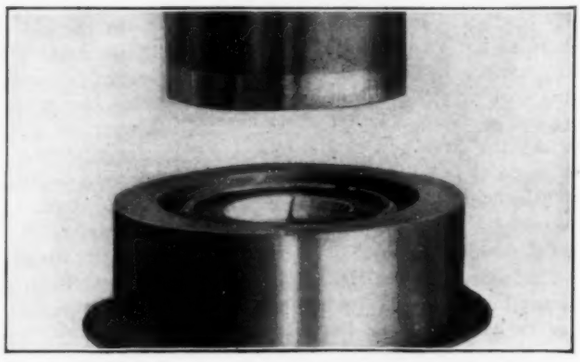


FIG. 1. MAKING A SELF-CLEANING GEAR



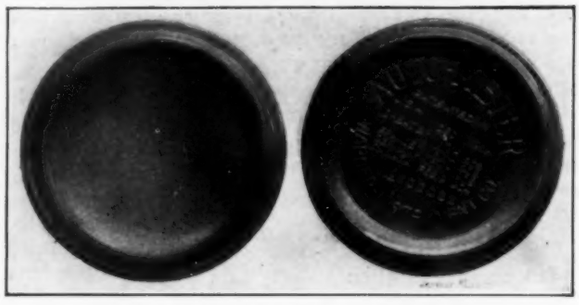


FIG. 2. TURNING OVER THE EDGE
FIG. 3. SOME HEAVY BRASS STAMPING

After this, it is ready for the final punching of the center holes which support the gear and also give a positive drive by means of the keyhole, to the flexible shaft which transmits the motion to the auto-meter on the dashboard.

The teeth are cut in the regular way and it will be seen how this construction allows any dirt that may fly up on the gearing to be forced through the opening in the center of the piece.

SUB-PRESS IN A DROP HAMMER

Another interesting, though not intricate piece of stamping is shown in Fig. 3, which is the cover on the top of the instrument. This work is done under a drop hammer as shown in Fig. 4. The sub-press is shown in position with a cap in place on the die. The sub-press is of very simple construction, the ram being returned by the small, spring-actuated lever shown on each side, and the whole thing very easily operated. This seems to be one of the places where a sudden blow as is obtained by a drop hammer, gives more satisfactory results than with a crank or other press.

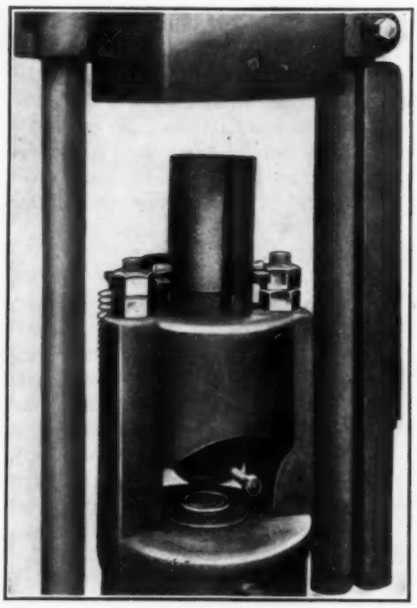


FIG. 4. SUB-PRESS FOR DROP-HAMMER USE

One of the nicest pieces of punch work we have seen is the style of the instrument which is shown in Fig. 5. This has a silvered face and as shown at the left is still on the square blank which has not been punched out. It will be noticed, however, that there is a depression in the plate between the words "Miles per Hour" and "Warner." This is the opening through which the speed is read and is depressed in this way in order to bring it close to the revolving indicator showing the speed.

This depression is made in a special hydraulic die, oil pressure being used on top to prevent any marring or crimping of the dial. The view on the right in Fig. 5 shows the finished dial as punched out by the punching die shown in Fig. 6. This is a beautiful piece of die making and leaves every cut edge so smooth that it hardly seems possible that the bur has not been removed in

some way. This punching includes the three oblong holes, the round hole at the top and the three small screw holes for attaching the dial to the case.

Facing a Curved Flange

It is one of the claims for this instrument that its case is absolutely watertight, and as the flexible shaft goes in below the center it makes a peculiarly shaped joint between the outside of the case and the bushing or gland through which the flexible shaft must go.

This gland has a piece which projects through the case and its flange must accurately fit the curved surface of the case in order to make a good joint.

Some of these glands are shown in the lower right-hand corner of Fig. 7 which also shows how these flanges are machined quickly and accurately. The gland to be turned is mounted on the right-hand end of the mandrel, being driven by the key which projects into the small square slot shown on one side. A special tool block is mounted on the lathe and carries two clamps. The right-hand clamp holds the cutting tool, while the one at the left carries a piece of steel having a hardened, rounded point which bears against the cam seen at the left.

As the mandrel and cam revolve it is very easy to see how the cutting tool at the right is made to travel laterally, and in this way to turn the hub and face off the flange to the exact contour desired, all depending on the correctness of the cam on the other end of the mandrel. This work is done on a Rivett lathe, and the pieces are handled in remarkably quick time.

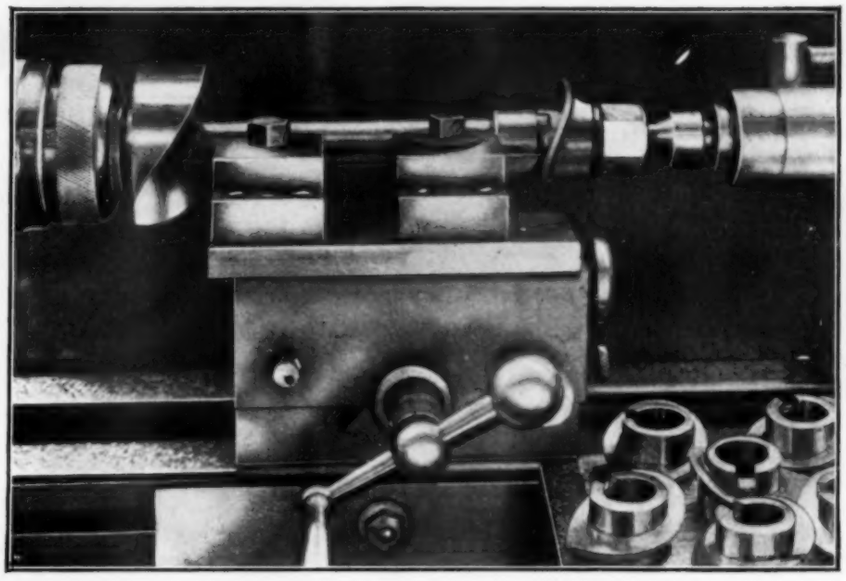


Fig. 7. Device for Turning Curved Flanges

Fig. 5. Dials before and after Punching

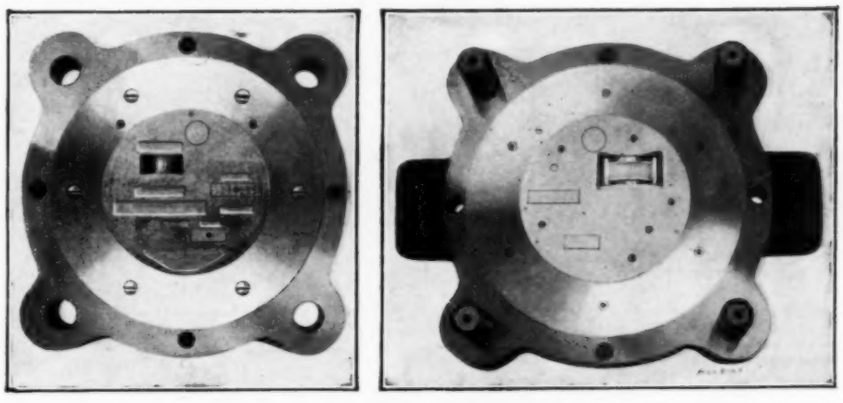


Fig. 6. Punch and Die for Dials

Watch Out for the Corners

The careless and the inexperienced fitter or assembler can usually be detected in a very short time by the manner in which he leaves the corners of work which has passed through his hands. It is the business of the draftsman and the patternmaker to make provision for the elimination of corners from exterior surface intersections. It requires but a very short time to cut or grind off a sharp, projecting corner, the absence of which usually adds a great deal to the appearance of a machine and to the comfort of the man who has to operate it.

Then there is another form of corner which gives a great deal of trouble when it escapes the machinist. This kind of corner develops when a drill breaks through the surface of a piece of metal at the bottom of a hole. As the drill comes through, its rate of feed increases greatly and it does not cut as large a hole as when it was being fed slower. Thus, even when a drill is passed through a hole all right, the coming-out end thereof is liable to be left smaller than the rest of the hole, and a shaft or a bolt thrust into the hole, passes freely until it gets to the bottom, and there it sticks to the great disgust of the setter-up.

Always make sure that the "coming-out" portion of a drilled hole has been reamed sufficiently to remove the thread of metal which causes this trouble. It should be against the law to use a drilled hole without reaming it, but many a hole must be thus used and a little care in removing the metal left by the breaking through of the drill will save a good deal of time and vexation when the machine is being assembled.

Bronze and Babbitt Linings

Editorial Correspondence

An up-to-date railroad babbitting plant containing several devices for rapidly and economically doing various kinds of babbitting work.

Babbitting plays a large part in modern railway work, as can be seen by the attention given to it in any of the up-to-date shops. Fig. 1 shows part of the babbitting plant of the Beech Grove shops of the Big Four railroad, which is very complete and handles large quantities of work very rapidly. The fixture in the foreground is for babbitting trailer boxes and consists of a turret, or turntable, carrying a number of forms. The brass which is to be babbitted is placed over the form in front of the pneumatic holding device, which is between the two turrets. Admitting air behind the piston of this forces the two pointed studs against the back of the brass and holds it firmly against the form which represents the axle. This holds the brass firmly while it is being poured and after pouring, water is turned on from the jet inside the turret to cool the molds, the drip pan below taking care of the waste water. Then the exhaust valve of the air cylinder is opened, the clamping points withdrawn and the turrets turned so that the next box comes into position to be poured in the same way.

The machine shown in the distance is for babbitting crosshead shoes, the operation being very similar in every respect. The details are all shown in Fig. 2 and make further explanation unnecessary.

Fig. 3 shows the babbitting mandrel used for crosshead shoes, the parts to be babbitted being simply clamped on the outside of the mandrel and the babbitt poured in the usual way, as can be seen in Fig. 6, which is from a photograph taken at the New York Central shops, at Depew, N. Y.

Fig. 4 shows a gasket mold made for the engineer's brake valve at the Beech Grove shop, which needs practically no explanation. Substantial tongs are fas-

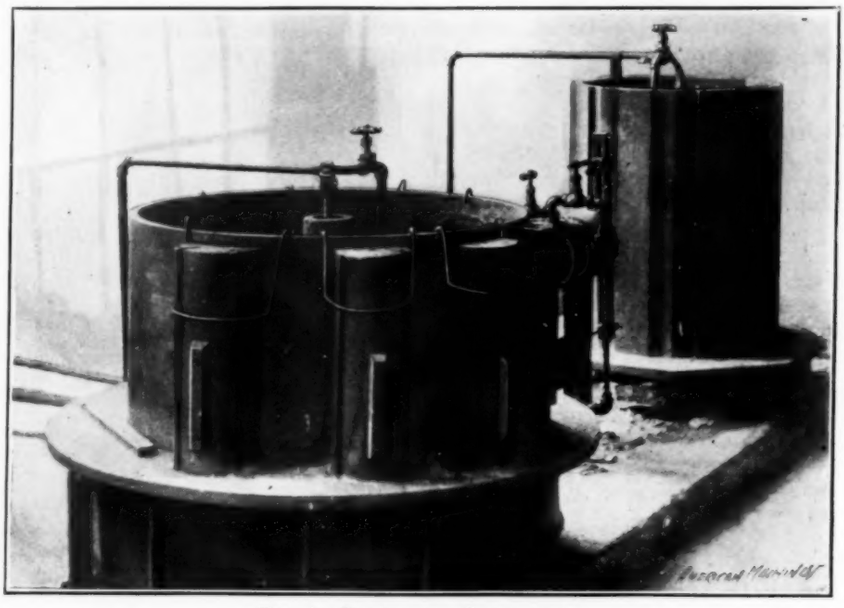


FIG. 1. PLANT FOR BABBITTING

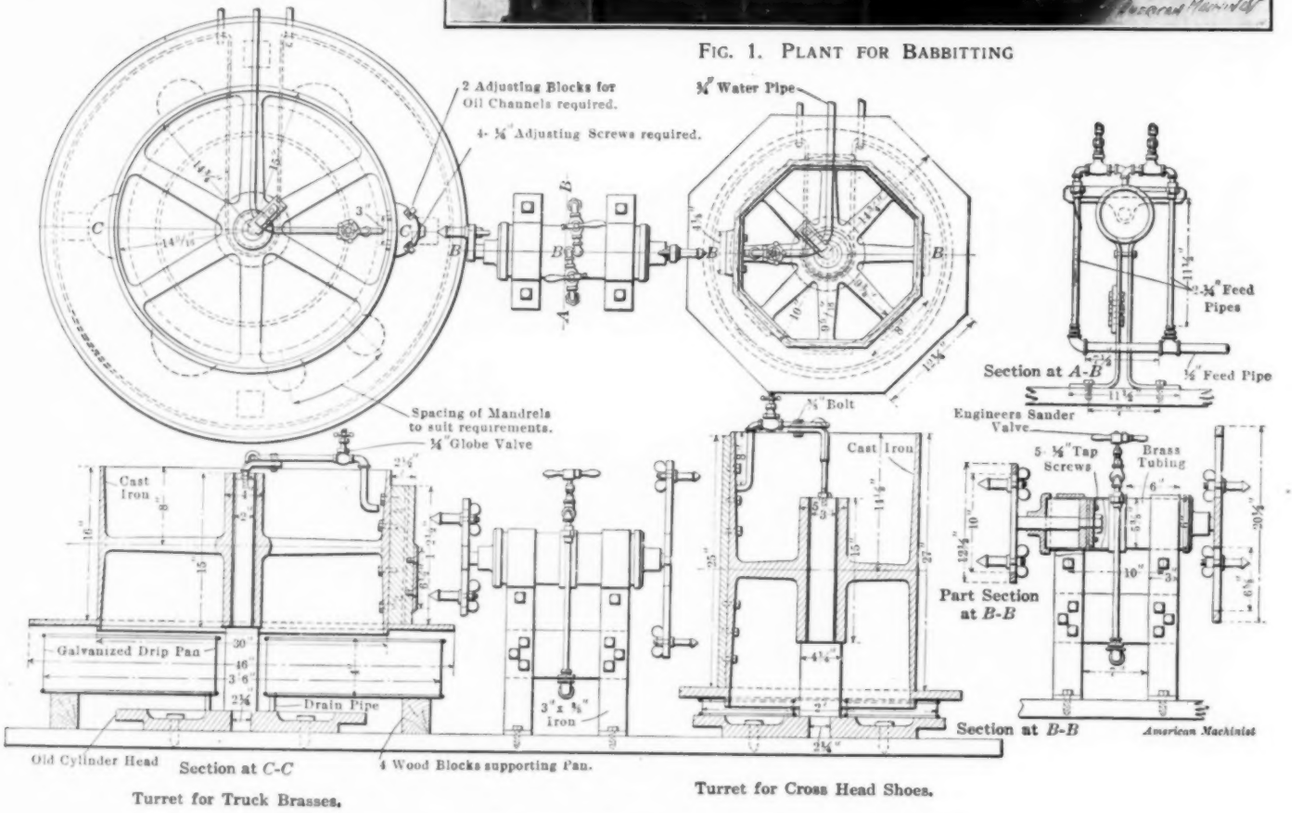


FIG. 2. BABBITTING CROSSHEAD SHOES, TRAILER AND TRUCK BRASSES

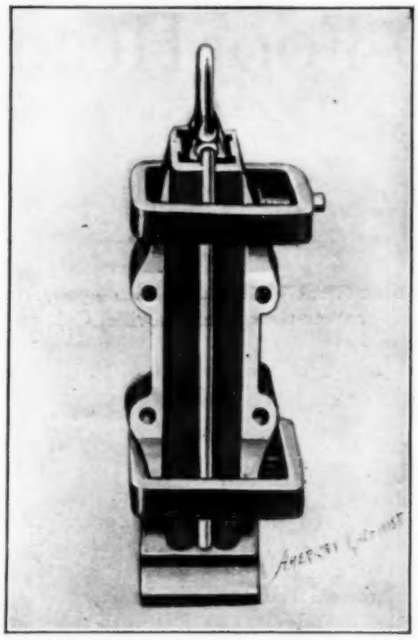


FIG. 3. BABBITTING MOLD FOR CROSSHEAD SHOES

tened to the side of the mold by ¼-inch screws, which makes it a very convenient tool to handle.

Fig. 5 shows the way in which crosshead shoes are repaired at the Depew shops of the New York Central Line. These shoes are steel castings and are planed so as to leave the wide dovetailed tong in the center, while the sides are undercut and have cross grooves, which hold the babbitt firmly against any tendency to be moved endwise.

These are babbitted as shown in Fig. 6, which shows a pair of shoes in the foreground ready to be poured. The oil furnace in the foreground melts the bronze which is then poured into a crucible, and from this to the various molds shown in the foreground. The steel driving boxes have their hub liners cast in this way and the crosshead shoes are arranged in the center of the group. In the extreme foreground is a rocker box which is to have a bronze shelf passed in it and around the iron core in the center.

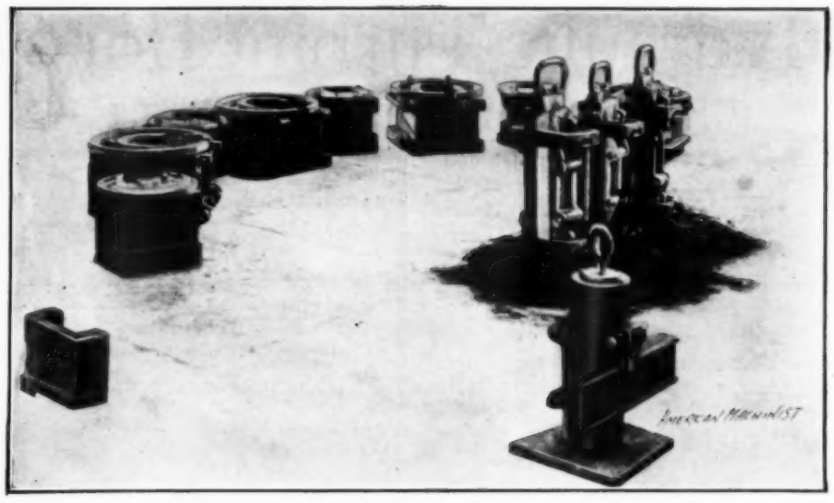


FIG. 6. CASTING BRASS LINERS AT THE DEPEW SHOPS

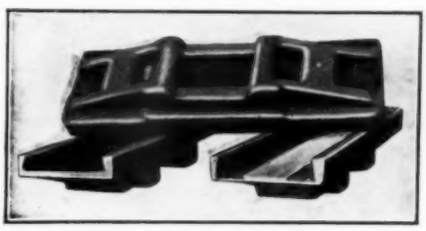


FIG. 5. CROSSHEAD SHOES PLACED READY FOR LINING

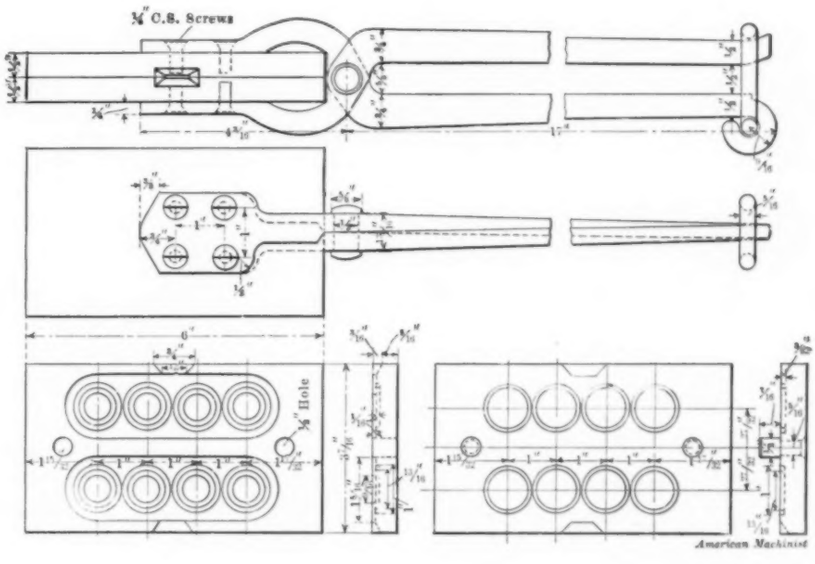


FIG. 4. GASKET MOLD FOR ENGINEER'S VALVE

Repairing Broken Drills by Welding

The chap who "can mend a file by welding it" is not always easily found, but the welding of a broken twist drill is so easy a matter that there is no excuse for a lot of broken drill-ends to be found in the shop. Just prepare the broken-off piece for welding in the usual way, then fix up a bit of cold-rolled steel—a small piece of shaft of the required diameter will answer first rate. Just scarf it if intended for a lap weld, or round one end slightly if it is to be a butt joint.

Take a good soft welding heat on the cold-rolled piece, and a low yellow heat on the broken drill. Fluz with borax or lime. Lime makes a very good flux for steel. In fact, lime is the natural flux for that metal. Either pulverized limestone or marble, or hydrated lime may be used as either may be at hand. Don't hammer too quickly. Place the lap or butt fairly together, then press down the cold-rolled steel which should preferably be on top. Press down by hammering very lightly at first, gradually increasing the weight of the hammer blows, and continue the light hammering until the weld has been fully made.

Should a corner of the steel fail to unite properly, or should there be a place which does not contain enough metal to finish full size, then open the weld a little with a cold-chisel, and drive in the corner of a bit of very soft iron. A bit of a scythe answers admirably for this purpose and it will help unite the steel and the cold-rolled metal, as well as to help fill out a cavity in the weld.

Hydraulic Turbines for 670-Foot Head

By H. Birchard Taylor*

A distinct advance in the design and application of hydraulic turbines is marked by the construction of two 6000-horsepower reaction turbines which are to be operated under a 670-foot head at Noriega, Mexico. Owing to this high head, special attention had to be given to the proportioning of parts and to the means of regulation.

*Assistant hydraulic engineer, I. P. Morris Company.

There are now in the course of construction, in the shops of the I. P. Morris Company, of Philadelphia, two hydraulic reaction turbines which will be applied to a head higher than has ever before been attempted for this type of water-wheel. They are to be installed in the power plant of the Michoacan Power Company at Noriega, Mexico.

The turbines are of the horizontal-shaft volute-casing, inward-flow, Francis type and each is designed to deliver at its flange coupling, 6000 horsepower, when operating under an effective head of 670 feet at a speed of 514 revolutions per minute. They will be directly connected to 3500-kilowatt, 60-cycle, three-phase generators, manufactured by the General Electric Company.

When delivering 6000 horsepower under the above conditions of head and speed, each turbine will require 98.7 cubic feet of water per second. Therefore, when both units are delivering full power, 197.4 cubic feet of water per second will be required. The water will be supplied to both turbines through a single penstock about 5600 feet in length.

It has been only within the last few years that the reaction type of turbine has been applied to heads much over 300 feet. Some of the more recent applications of the reaction turbine to high heads have proved conclusively that the erosion of the runner vanes in high-head turbines is due primarily to defective design, and not to foreign substances in the water, poor material, electrolysis, or chemical action.

The successful operation of the four 18,000-horsepower turbines in the plant of the Great Western Power Company, on the Feather river, near Oroville, Cal., has greatly strengthened the confidence of engineers in the reaction turbine, as a type well adapted to compete with the impulse turbine, for heads probably as high as 1000 feet. The runners of the Great Western turbines are not all of the same material; two are made of bronze, one of cast steel and one of cast iron. All have been operating continuously for a year without showing any signs of erosion. The present head under which they operate is 420 feet, but this will be increased to 525 feet when the dam is completed.

Hydraulic engineers are awaiting with considerable interest the time when the Noriega turbines will be put into commercial operation, as the construction of these units marks a distinct advance in the art of hydraulic-turbine design and their successful operation will greatly broaden the field for the reaction type.

The new 6000-horsepower turbines are of the single-runner, single-discharge type with outside operating mechanism. Each casing is made of cast steel in two sections, the division occurring on the horizontal plane which passes through the axis of the shaft. The normal pressure in the casing will be about 285 pounds per square inch, but owing to the wide fluctuations of pressure resulting from the sudden stopping and starting of the water column in the penstock, the turbine casing has been designed to withstand a pressure of 585 pounds per square inch. The sizes of the various parts of the turbine subject to this pressure are so proportioned that the resulting stresses will not exceed the elastic limits of the metals used in their construction.

Each casing is securely tied by 17 heavy forged-steel staybolts, which, aside from preventing excessive strains in the metal of the casing by taking a large proportion of the load upon themselves, are so arranged as to prevent an appreciable change in the width of the throat opening of the casing where the guide vanes are situated. Both casings have been subjected to a hydraulic-pressure test of 585 pounds per square inch. The accompanying illustrations show one of the turbines erected in the shop for this test.

The runner of each turbine is made of special bronze in a single casting

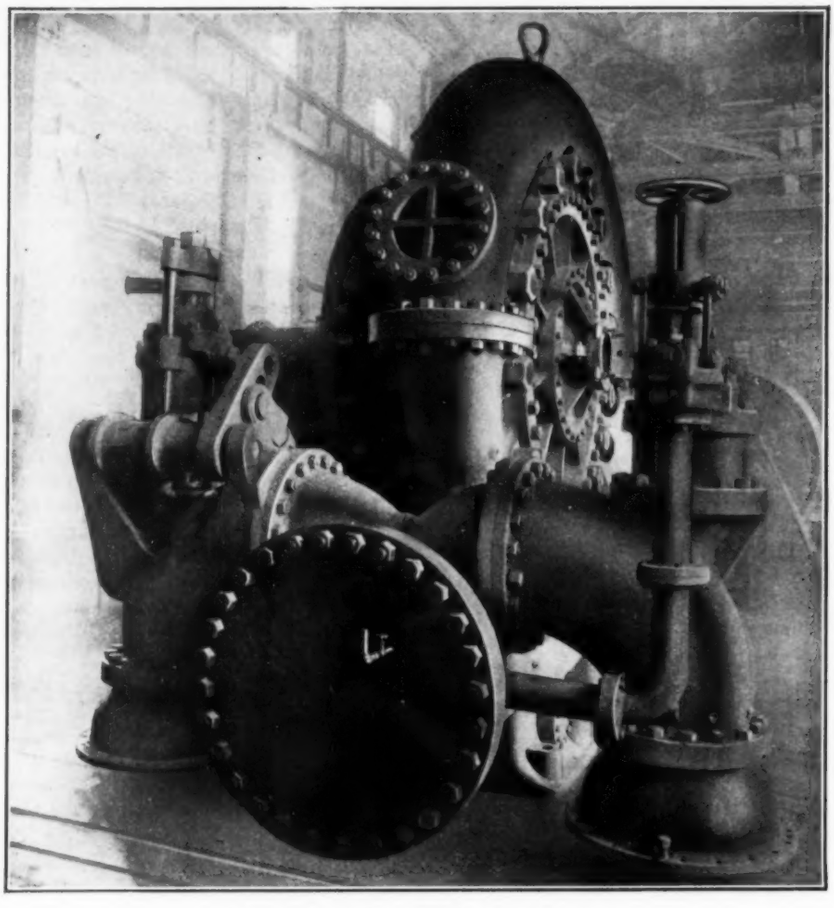


FIG. 1. VIEW SHOWING RELIEF VALVES

and is securely bolted to a hub forged on the shaft. All the vane surfaces have been finished smooth so as to reduce to a minimum the frictional losses.

Provision has been made to balance the hydraulic thrust on the runner, but should any unbalanced thrust occur it will be taken care of by a thrust bearing located on the tail end of the shaft.

The forged-steel shaft which revolves in two ring-oiling bearings is made of such a diameter as to prevent any appreciable deflection at the runner. It is therefore possible to use scant clearances between the runner and the stationary parts, thus preventing unnecessary losses in efficiency by cutting down the leakage at the seals.

The water will be distributed to the runner through cast-steel movable guide vanes controlled by the cast-steel operating ring, which turns in a groove in the outboard headplate. The lower part of the ring is connected to the piston rod, which is controlled by the main operating cylinder mounted on the turbine casing.

The entire operating mechanism is so designed that should any two vanes close on a stick which has passed through the racks at the headgates, the two vanes will be capable of sustaining the entire force of the governor, without causing any permanent distortion of the vanes. This arrangement not only reduces the maintenance charges by increasing the life of the guide vanes, but it also prevents excessive leakage when the vanes are in the closed position.

The thrust-bearing pedestal is mounted on a subbase which in turn is mounted on a sole plate securely bolted to the concrete foundations. Thus, if it should be desired to dismantle the turbine, the bolts connecting the cap to the pedestal may be removed and the bolts which connect the pedestal to the sole plate may then be withdrawn. The subbase may then be slipped out from beneath the pedestal and the latter dropped down and removed from under the thrust collars on the shaft. The draft bend and the headplate containing the operating mechanism may then be unbolted and removed from the casing and slipped over the tail end of the shaft.

Owing to the high head under which these turbines will operate and the likelihood of the seals between the runner and the stationary parts increasing at a rapid rate, the turbines have been equipped with removable cast-iron plates at these points. These plates may be removed from time to time when the clearances become too large. Thus no permanent damage to the turbines will result from the action of the water.

Removable plates are also supplied on both sides of the throat of the casing where the guide vanes are situated. These plates are made of cast steel and will protect the turbine casing from wear caused by the scouring action of the water, as it passes with high velocity through the guide vanes.

Each turbine is supplied with a small hand-operated oil pump mounted on the operating cylinder and connected through piping to a jack cylinder superimposed upon the end of the operating cylinder. The piston rod which controls the operating ring passes through the main operating cylinder and terminates at a piston in the jack cylinder. In case the governor system should fail the turbine may be operated by the hand pump through the jack cylinder.

The speed with which the turbine gates are opened or closed by the governor to suit the changes in the load.

The flywheel effect of the revolving parts of the turbine and generator.

Turbines which are fed by long penstocks are subject to wide fluctuations of the pressure in the wheel casing. The magnitude of the pressure change depends upon the length of the penstock and upon the rate of the change in the velocity of the water column in the penstock. The latter depends upon the velocity with which the gates are moved to

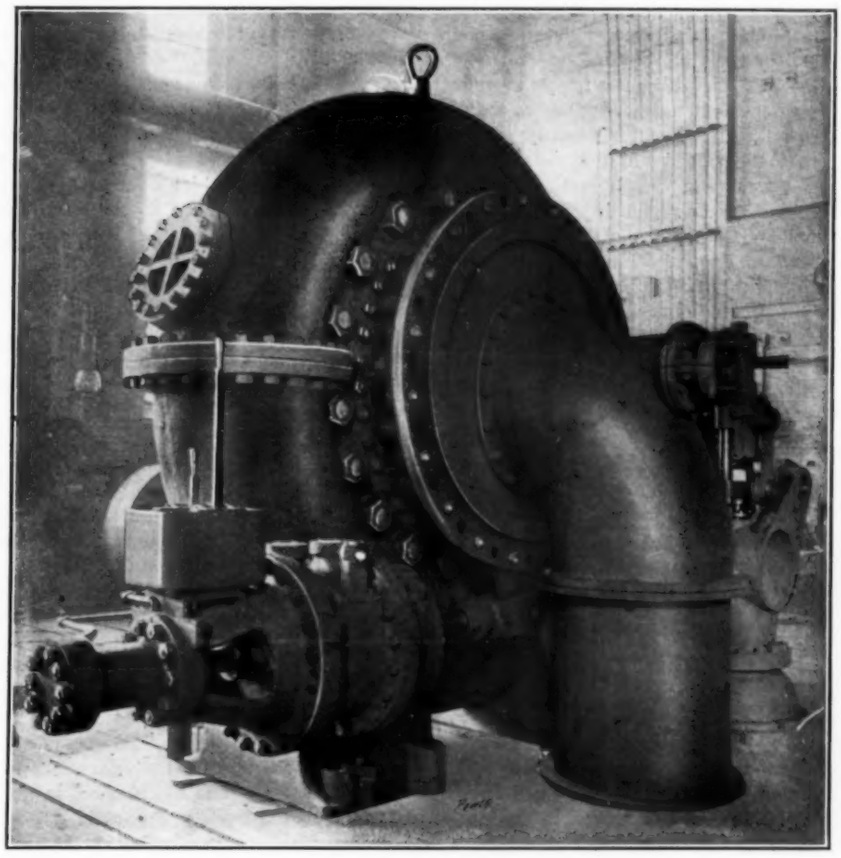


FIG. 2. SHOWING OPERATING MECHANISM

The problem of designing the turbines for good speed regulation has been an extremely difficult one, owing to the fact that they are fed through a penstock 5600 feet long and that the flywheel effect of the generator amounts to only 108,000 pounds at one foot radius.

The speed regulation of a turbine is not wholly dependent upon the installation of a first-class governor. Of course, a first-class governor is essential to good governing but the best governor constructed will not insure good regulation if the conditions are not favorable.

The principal factors entering into the regulation problem of every turbine which is supplied with water through a penstock are as follows:

The inertia of the water in the penstock.

suit the variations in the load on the turbine.

When the load suddenly drops, the gates are partly closed by the governor and the quantity of water delivered to the runner is thereby reduced to an amount required to balance the new load, at the normal speed. The closing of the gates reduces the velocity of the column of water in the penstock and, as it requires force to change the velocity of a body, this force is evidenced by a rise in pressure in the wheel casing.

Again, when a load suddenly comes on the turbine, the gates are opened by the governor and the quantity of water delivered to the runner is increased to an amount required to balance the new load at the normal speed. The opening of the gates allows an increase in the velocity of the water column in the penstock and

as it requires a force to change the velocity of a body, this force is evidenced by a drop in the pressure in the wheel casing.

If the pressure in the wheel casing is increased or decreased, it is equivalent to operating the turbine under a higher or lower head and this change in the head exists during the time in which the gates are being adjusted to suit the change in the load. Should the gates be moved too rapidly, the pressure change will become a greater factor in controlling the speed of the turbine than the change in the quantity of water resulting from the movement of the gates.

To illustrate this point, let us assume that a portion of the load on the turbine drops off and the gates close to reduce the amount of energy supplied to the runner. The rise in the pressure will increase the velocity of the water through the gates and the quantity delivered through smaller gate openings will be considerably above the normal discharge for these openings based on a constant head. The product of the increased pressure times the quantity of water delivered per second is a measure of the energy supplied to the runner and this energy might be greater than that which would have been the case had the pressure remained constant during the closing of the gates. Thus, the whole scheme of regulation is upset.

In practice the pressure fluctuations are usually modified by the installation of standpipes, surge tanks and relief valves, but in all cases the allowable velocity of the gates is largely dependent upon the design of the penstock.

Assuming that the movement of the gates does not cause a change in the pressure in the casing, then if the load goes off and the gates close to suit the new condition of load, the excess energy supplied to the runner during the movement of the gates is taken up by the revolving parts and the speed of the turbine increases. For a given amount of energy the rise in speed depends directly upon the flywheel effect, or the weight multiplied by the square of the radius of gyration of the revolving parts. The greater the flywheel effect, the smaller the speed change.

Conversely, when the load on the turbine is suddenly increased and the gates open to suit the new load, the deficiency in the energy supplied to the turbine, during the movement of the gates, is supplied by the revolving parts as the speed is reduced. For a given amount of energy taken from the revolving parts, the drop in speed depends upon the flywheel effect.

Thus, it is seen that for good governing, it is desirable to have as great a flywheel effect as is practicable and in cases where the revolving parts of the generator will not supply the value sufficient to obtain the degree of regulation required, it is then necessary to increase the inertia of the revolving parts by the addition of a flywheel on the turbine shaft.

The various factors entering into the problems of regulation—the inertia of the water in the penstock, the relief valves, the standpipe, the flywheel effect, and the speed with which the gates are moved, are all more or less related and it is essential that they be carefully studied and each factor given its due attention by the engineer in making his guarantees of regulation.

In order to secure the regulation desired by the Michoacan Power Company, it was found necessary to increase the flywheel effect (Wr^2) of the revolving parts to 282,000 pounds at one-foot radius, by the addition of a cast-steel flywheel weighing approximately 20,000 pounds. It will be located between the generator bearing and the turbine bearing, and will be mounted and keyed to the generator shaft and bolted to the forged-flange coupling on the turbine shaft.

The flywheel is so designed that when operating at the runaway speed of the turbine, which will be about 900 revolutions per minute, the stress in the rim will not exceed the elastic limit of the material.

Owing to the question of safety as well as speed regulation, it is necessary that the variation of the pressure in the turbine casing, caused by the stopping and starting of the water column in the penstock, shall not exceed certain limits. In order to control these variations in pressure, each turbine is equipped with a mechanically operated, cast-steel body, relief valve connected to the turbine casing.

The relief valve is arranged to be actuated by a mechanical connection through a dashpot, to the operating ring of the gate-operating mechanism, in such a manner that, when the turbine gates are suddenly closed, the relief valve will open. The construction of the relief valve is such as to discharge practically the same amount of water that is shut off by the turbine gates.

The relief valve is also arranged so that it may be operated as a synchronous bypass, discharging water in inverse proportion to that being used by the wheel, thus keeping the velocity in the penstock constant and preventing variations of the pressure in the wheel casing. It may also be arranged so as to be used as a water-saving bypass, that is, when the turbine gates are suddenly closed, the relief valve will open and prevent an abnormal rise of pressure, and will then slowly close at such a rate as to keep the pressure in the pipe line within the required limits.

There will also be provided for each turbine and attached to the turbine casing a steel-body, pressure-actuated, relief valve which will be capable of discharging the full quantity of water used by the turbine. This relief valve will be operated by a rise of pressure in the pipe line, and will be so designed as to open in proportion to the rise in pressure and with a decrease in pressure, the valve will close and shut off a proportionate amount of water.

The gates of the turbines will be controlled by Morris governors of the double-floating lever, oil-pressure type. Each governor will be operated by a belt from the turbine shaft, and in addition is equipped with a motor so that it may be controlled from the switchboard. In order that the revolving element of the governor may be stopped during the operation of the turbine without disturbing the driving belt, a friction clutch is provided on the governor pulley.

The governing apparatus of each turbine consists of a governor, accumulator tank, three-throw oil pump and the interconnecting piping. The accumulator tank is divided into pressure and vacuum compartments. The oil pump is of the Deane, vertical, three-throw type and is driven from the turbine shaft by means of a belt. The interconnecting piping and fittings between the pump, governor, accumulator tank and operating cylinder are made of brass and all parts are so designed that the governor will control the turbine gates satisfactorily with a working pressure not exceeding 150 pounds per square inch.

When operating under an effective head of 670 feet at the normal speed of 514 revolutions per minute, each turbine is guaranteed to have an efficiency of at least 80 per cent. when delivering 6000 horsepower, at least 82 per cent. when delivering 5000 horsepower, and 80 per cent. when delivering 4000 horsepower.

In a paper presented to the Franklin Institute by F. H. Gunsolos, dealing with the subject of explosives, it is pointed out that gunpowder was known in a crude form by the Chinese for many centuries, but the earliest date of which there is record and which can be considered authentic in any way is 1264, when Roger Bacon made known the results of his tests. Not until 1629 was gunpowder used as a blasting agent, at which time Casper Weindl invented the use of gunpowder for blasting purposes. A demonstration was made at Schemnitz in Hungary, where it was shown conclusively that its use would materially aid in mining and quarrying operations. Until the beginning of the nineteenth century, however, no other explosive was introduced into practice with success. In 1788 Bertholet and Lovoisier tried the effect of adding potassium chlorate, and in 1861 Designolle made a powder from potassium picrate and saltpeter but without much success. In 1846 Schoenbein invented gun-cotton and in 1847 Sobero discovered nitroglycerin.

	Silicon.	Sulphur.	Phos.	Mang.	Comb. Carb.	Total. Carb.
Friction Clutches:						
	2.00–2.50%	und. 0.15%	und. 0.70%	und. 0.70%		
Sug.	1.75–2.00	0.08–0.10	und. 0.30	0.50–0.70		low
Furnace Castings:						
	2.50%	und. 0.07%	und. 0.20%	0.80–1.0%		
	2.00	0.085	0.35	0.53		
	1.85	0.090	0.70	0.60		
Sug.	2.00–2.50	und. 0.06	und. 0.20	0.60–1.00		low
Gas Engine Cylinders:						
	1.45%			0.65%		
	1.98	0.090%	0.84%	0.63		
	1.21	0.117	0.40	0.35	1.40%	3.74%
	1.00–1.25	0.04–0.08	0.20–0.40	0.70–0.80	0.60–0.80	3.00–3.10
Sug.	1.00–1.75	und. 0.08	0.20–0.40	0.70–0.90		3.00–3.30
Gears, Heavy:						
	1.40%	0.060%	0.10%	0.40%		
	0.94	0.150	0.43	0.31	1.47%	
	1.60	0.080	0.40	0.60		3.50%
	1.50–1.75	0.080	0.40–0.60	0.50–0.70		
	1.00–1.25	0.075	0.40	0.80–1.0		very low
	1.40–1.60	0.04–0.08	0.30–0.50	0.40–0.60	0.50–0.80	3.20–3.40
Sug.	1.00–1.50	0.08–0.10	0.30–0.50	0.80–1.0		low
Gears, Medium:						
	1.50–2.00%	und. 0.08%	0.35–0.60%	0.50–0.80%		
	1.90	0.060	0.10	0.40		
	2.30	0.060	0.60	0.60		3.75%
	1.90	0.100	0.69	0.58	0.55%	3.83
Sug.	1.50–2.00	und. 0.09	0.40–0.60	0.70–0.90		
Gears, Small:						
	3.43%		1.42%	0.90%		
	2.00	0.100%	0.50	0.70		3.50%
Sug.	2.00–2.50	und. 0.08	0.50–0 70	0.60–0.80		
Grate Bars:						
	2.75%	low	low			
	2.00	0.085%	0.35%	0.53%		
Sug.	2.00–2.50	und. 0.06	und. 0.20	0.60–1.0	und. 0.30	low
Grinding Machinery, Chilled Castings for:						
	0.50%	0.200%	0.45%	1.50%	3.00%	3.00%
Sug.	0.50–0.75	0.15–0.20	0.20–0.40	1.5–2.0		
Gun Carriages:						
	0.94%	0.050%	0.44%	0.31%	0.63%	3.03%
	1.00	0.050	0.30	0.60	1.10	2.50
Sug.	1.00–1.25	und. 0.06	0.20–0.30	0.80–1.0		low
Gun Iron:						
	1.34%	0.003%	0.08%	1.00%	0.93%	3.12%
	1.19	0.055	0.41	0.42	1.13	3.18
	1.53	0.050	0.29	0.45	0.42	3.43
	0.98	0.06	0.43	0.43	0.75	1.74
	0.30		0.44	3.55	1.70	3.90
	1.20	0.100	0.30	0.80	1.00	3.00
Sug.	1.00–1.25	und. 0.06	0.20–0.30		0.80–1.0	low
Hangers for Shafting:						
	1.60%	0.040%	0.55%	0.55%	0.30%	3.57%
Sug.	1.50–2.00	und. 0.08	0.40–0.50	0.60–0.80		
Hardware, Light:						
	1.84%		0.58%	1.04%		
	2.20		0.74	1.10		
	2.50		1.21	1.16		
	2.51	0.110%	0.62	0.41	0.24%	3.18%
	2.70	0.030	0.60	0.50	0.40	3.60
	2.50	und. 0.050	0.60	0.70		
	2.00–2.25	0.050	0.85	0.40		3.85–4.00
Sug.	2.25–2.75	und. 0.08	0.50–0.80	0.50–0.70		
Heat Resistant Iron:						
	1.20%	0.060%	0.10%	0.40%		
	1.67	0.032	0.09	0.29	0.43%	3.87%
	2.15	0.086	1.26	0.41	0.13	3.30
	2.02	0.070	0.89	0.29	0.84	3.60
	1.53	0.040	0.33	1.08	0.58	3.68
	2.07	0.073	0.31	0.48	0.23	2.64
	1.80	0.030	0.70	0.60		
	2.75	low	low			
	2.50	und. 0.07	und. 0.20	0.80–1.0		
	1.76	0.075	0.63	0.79	0.56	3.68
	2.00	0.030	0.70			
Sug.	1.25–2.50	und. 0.06	und. 0.20	0.60–1.00	und. 0.30	low
Hollow Ware:						
	2.51%	0.110%	0.62%	0.41%	0.24%	3.18%
Sug.	2.25–2.75	und. 0.08	0.50–0.70	0.50–0.70		
Housings for Rolling Mills:						
	1.00–1.25%	0.085%	0.65%	0.75%		low
Sug.	1.00–1.25	und. 0.08	0.20–0.30	0.80–1.0		low

	Silicon.	Sulphur.	Phos.	Mang.	Comb. Carb.	Total Carb.
Hydraulic Cylinders, Heavy:						
	1.00%	0.050%	0.30%	0.60%	1.10%	2.50%
	0.90	0.136	0.39	0.25	1.44	3.34
	0.80–1.50	0.07–0.11	0.35–0.50			
	1.12	0.85	0.40	0.70	0.70	3.50
	0.95	0.100	0.30	0.90	0.80	3.40
	1.15	und. 0.08	0.50	0.60	1.15	
	0.90–1.20	0.06–0.08	0.30–0.50	0.80–1.0	0.80–1.0	2.90–3.10
Sug.	0.80–1.20	und. 0.10	0.20–0.40	0.80–1.0		low
Hydraulic Cylinders, Medium:						
	1.40%	0.060%	0.10%	0.40%		
	1.90	0.074	0.50	0.65		
	1.62	0.08	0.50	0.60		
	1.75	0.070	0.40	0.55	0.50%	
Sug.	1.20–1.60	und. 0.09	0.30–0.50	0.70–0.90		low
Ingot Molds and Stools:						
	1.20%	0.060%	0.10%	0.40%		
	1.67	0.032	0.09	0.29	0.43%	3.87%
Sug.	1.25–1.50	und. 0.06	und. 0.20	0.60–1.0		
Locomotive Castings, Heavy:						
	1.40–2.00%	und. 0.085%	und. 0.60%	und. 0.70%		
	1.25–1.50	0.06–0.08	0.40–0.60	0.45–0.60	0.50–0.70%	3.50%
	1.62	0.098	0.42	0.49		
Sug.	1.25–1.50	und. 0.08	0.30–0.50	0.70–0.90		
Locomotive Castings, Light:						
	1.40–2.00%	und. 0.085%	und. 0.60%	und. 0.70%		
	1.50–2.00	0.06–0 08	0.40–0.60	0.45–0.60	0.45–0.55%	3.50%
Sug.	1.50–2.00	und. 0.08	0.40–0.60	0 60–0.80		
Locomotive Cylinders:						
	1.25–1.75%	und. 0.10%	und. 0.90%			
	1.40–2.00	und. 0.085	und. 0.60	und. 0.70%		
	1.25–1.50	0.06–0.08	0.40–0.60	0.45–0 60	0.50–0.70%	3.50%
	1.00–1.40	und. 0.11	0.40–0.90	0.40–0.90		
	1.41	0.092	0.38	0.39		
	1.56	0.061	0.45	0.78		
Sug.	1.00–1.50	0.08–0 10	0.30–0.50	0.80–1.0		
Machinery Castings, Heavy:						
	1.05%	0.110%	0.54%	0.35%	0.33%	2.98%
	0.85	0.030	0.35	0.92		
	0.80–1.50	0.030–0.050	0.35–0.50			
	0.90–1.50	0.09–1.2	0.15–0.40	0.20–0.80	0.10–0.30	2.50–2.90
	1.85	0.100	0.50	0.60		3.50
	1.30	0.090	0.40	0.60		
	1.85	0.120	0.60	0.45		3.40–3.55
	1.75	0.100	0.50	0.70	0.80	3.65
Sug.	1.00–1.50	und. 0.10	0.30–0.50	0.80–1.0		low
Machinery Castings, Medium:						
	1.83%	0.078%	0.50%	0.31%	0.43%	2.93%
	2.25	0.080	0.55	0.60		
	1.60	0.060	0.66			
	2.29	0.071	0.66	0.49		
	1.60	0.090	0.50	0.60		
	2.10	0.110	0.67	0.50		3.40–3.55
	2.25	0.060	0.75	0.55		
	2.00	0.100	0.75	0.50	0.75	3.50
	1.76	0.075	0.63	0.79	0.56	3.68
	2.00	0.100	0.50	0.50	0.50	3.60
	2.35	0.075	0.45	0.65	0.30	
	1.80	0.060	0.80	0.50	0.70	
	2.06	0.075	0.78	0.47		3.45
	1.40	low	0.20	0.40		
	2.00	0.030	0.70			
	1.85	0.08	0.60	0.50–0.60	0.50	3.25–3.50
	1.50–2.10	0.08–0.09	0.40–0.80	0.20–0.60	0.10–0.40	2.60–3.20
	1.80–2.10	und. 0.09	0.40–0.90	0.40–0.90		
Sug.	1.50–2.00	und. 0.09	0.40–0.60	0.60–0.80		
Machinery Castings, Light:						
	2.04%	0.044%	0.58%	0.39%	0.32%	3.84%
	2.25	0.080	0.70	0.50	0.20	3.55
	2.76	0.037	1.19		0.13	3.66
	2.49	0.097	0.90	0.42		3.40
	2.51	0.084	0.62	0.61		3.46
	2.50	0.100	0.60	0.70		3.50
	3.00	0.060	0.65	0.50		3.50
	2.40	0.050	0.47	0.59		
	2.85	0.064	0.67	0.65		
	2.52	0.062	0.66	0.68		
	3.15	0.050				
	2.50	0.100	0.70	0.60		3.40–3.55
	2.20–2.80	0.06–0.08	0.60–1.3	0.20–0.40	0.10–0.60	3.00–3.60
Sug.	2.00–2.50	und. 0.08	0.50–0.70	0.50–0.70		
Ornamental Work:						
	4.19%	0.080%	1.24%	0.67%	0.03%	2.88%
	2.51	0.110	0.62	0.41	0.24	3.18
	2.25		0.60–0.90			
Sug.	2.25–2.75	und. 0.08	0.60–1.0	0.50–0.70		
Permanent Molds:						
	2.15%	0.086%	1.26%	0.41%	0.13%	3.30%
	2.02	0.070	0.89	0.29	0.84	3.60
Sug.	2.00–2.25	und. 0.07	0.20–0.40	0.60–1.0		
Permanent Mold Castings:						
	2.00–3.00%					3.00–4.00%
Sug.	1.50–3.00	und. 0.06		und. 0.40		

CHEMICAL ANALYSES OF CAST IRON FOR VARIOUS PURPOSES.—II.

Interchangeable Involute Gearing*

By Wilfred Lewis†

The suggested system has a pressure angle of 22½ degrees and an addendum of 0.275 of the circular pitch.

*Presented at joint meeting of American Society of Mechanical Engineers and Institution of Mechanical Engineers.

†President, Tabor Manufacturing Company.

This paper was prepared at the request of the meetings committee of the American Society of Mechanical Engineers as the contribution to the discussion upon the need of a standard or standards for gears to be considered at the joint meeting with the Institution of Mechanical Engineers. By way of explanation, it may be said that its author is chairman of a committee on standards for involute gears, appointed about a year ago by the president of the American Society of Mechanical Engineers to investigate the subject of interchangeable involute gearing, and to recommend, if found desirable, a standard or standards. This paper, however, is not to be considered as an expression of the opinions of the other members of the committee, except where so stated.

After more or less unsatisfactory experience with cycloidal gearing, I investigated about 25 years ago the subject of involute gearing with the object of determining upon a system, for the firm of William Sellers & Co., with which I was then connected. The conditions imposed called for a system applicable to any number of teeth between a 12-tooth pinion and a rack, without change in the Sellers addendum which had always been made 0.3 pitch for the cycloidal

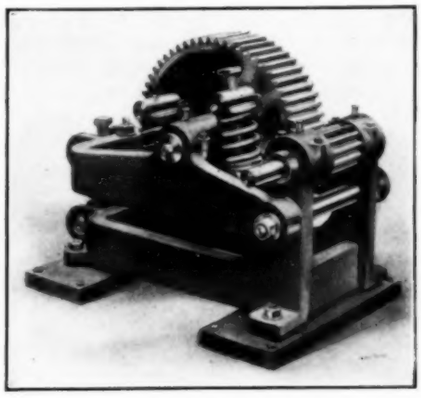


FIG. 1. GEAR-TESTING MACHINE

teeth, hitherto used almost exclusively by them.

I found that the involute forms then in vogue were confined to obliquities of 14½ degrees and 15 degrees, with an addendum equal to the modulus, or about 0.32 pitch. This long addendum with such small obliquities naturally gave rise to interference between racks and pinions of less than 30 teeth, and rather than modify the involute form, I finally recommended the adoption of a pressure angle of 20 degrees. At the same time, I was well aware of the fact that even this obliquity was not sufficient to prevent interference between a 12-toothed pinion and a rack, but for such pinions and the gears of 60 teeth or less, with which they commonly engaged, I believed the interference would not be noticeable in practice. I was strongly tempted to go further and fix upon an obliquity of 22½ degrees, but 20 degrees then appeared such a radical departure from common usage that the advantages of the greater angle were dismissed as being possibly more theoretical than real.

The 20-degree system with an addendum of 0.3 pitch has now been in use by William Sellers & Co., for 25 years and has given satisfaction in a general way, although the interference referred to has been more or less noticeable on 12-toothed pinions. I reviewed this matter 10 years ago in a paper read before the Engineers' Club, of Philadelphia, advocating an obliquity of 22½ degrees, and suggesting as a much needed reform in engineering practice the consideration of uniformity in interchangeable gearing. I then pointed to the action of the Franklin Institute more than 30 years earlier, which inaugurated a standard system of screw threads and expressed the hope that by the interchange of opinions an agreement among engineers might be reached leading to the gradual disappearance of needless diversity in the forms of gear teeth.

Nothing in this direction had been done, however, when the subject of interchange involute gear-tooth systems was brought to the attention of the American Society of Mechanical Engineers in a paper by Ralph E. Flanders presented in December, 1908. A number of systems in general use were analyzed and their merits discussed from various points of view, and the desire expressed that the council be petitioned to appoint a committee to investigate the subject of interchangeable involute gearing and, if found desirable, to recommend a standard or standards.

In answer to this petition, the council voted in January, 1909, that the president appoint a committee of five members to formulate standards for involute gears and present the same to the council. Without anticipating in any way the conclusions of this committee yet to be formulated, if indeed an agreement be possible, I believe it will be helpful to give publicity to the line of investigation upon which we have embarked and thus obtain the benefit of such criticism or encouragement as it may provoke.

At the first meeting of the committee in June, 1909, it was decided to obtain an expression of opinion from the manufacturers of gears and gear cutters and later in October the following circular letter was sent out:

TEXT OF LETTER ASKING FOR SUGGESTIONS

Dear Sir:

A committee of the American Society of Mechanical Engineers has been appointed to consider the subject of standards for interchangeable involute gears, and would like to have as much light upon the subject as can be given them by the manufacturers.

Without limiting in any way the type

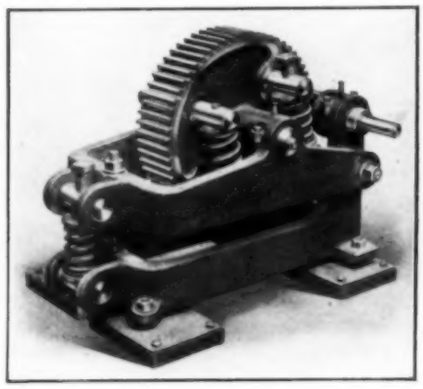


FIG. 2. ARRANGEMENT OF PIVOTED FRAME AND SPRING FOR MEASURING THRUST

of gears to be used for any special service, it is believed to be desirable that some type should be known as standard, so that any gears of that standard may run together and be perfectly interchangeable.

The committee is, therefore, interested to know the extent to which involute gears are modified in your practice to avoid interference, and it would be pleased to have your ideas as to what, in your opinion, should constitute standard interchangeable involute gears. Any

suggestion you may be pleased to offer will be very much appreciated.

Yours truly,

WILFRED LEWIS, *Chairman*
HUGO BILGRAM
E. R. FELLOWS
C. R. GABRIEL
GAETANO LANZA
Committee on Standards for Involute Gears

In response to the circular letter above referred to, about 100 answers were received, expressing more or less interest in the subject and giving more or less conflicting preferences and conclusions.

One correspondent said he would hail with delight any system whereby complete interchangeability could be attained on gears running without noise up to 1000 feet a minute, as among automobile manufacturers noiseless gearing was always the chief end in view.

It is undoubtedly true, as pointed out by other correspondents, that perfect cutters do not necessarily produce perfect gears and that close attention must be paid to the setting of the cutter, proper indexing, speed, feed, etc., and from the extent to which the present 14½-degree system is established, it has been argued that even if the pressure angle of 14½ degrees were not the most desirable, it would be better for the sake of the established practice to let it alone. Quite a number share this opinion and

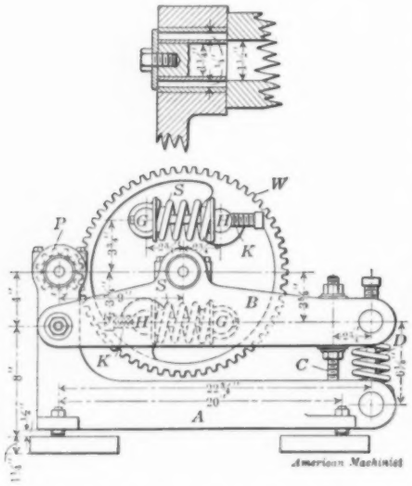


FIG. 3. DIAGRAM OF GEAR-TESTING MACHINE

argue against the recommendation of a standard which may simply add another system to those already in use.

It may be said in reply that the chief advantages of involute gearing over cycloidal gearing which it has pretty generally displaced are the comparative simplicity of the involute curve and a slight variation in center distances not permissible in any other system of gearing. Despite the difficulty of securing general recognition for any system of interchangeable gearing, I believe the committee should investigate and report upon some ideal standard or standards.

Attention is called by a number of correspondents to the increasing number of gears cut by the hobbing process and the difficulty of making such gears interchangeable with certain cut gears, thus indicating the hobbing principle as the first principle to which all cutters should conform, the rack being the basis of all generated gears. It is admitted that hobbed gears can be used interchangeably with gears cut by certain other processes, but some doubt is expressed of the possibility of realizing an interchangeable system using pinions with a small number of teeth and teeth of reasonable length without resorting to some modification of the involute curve. The opinion is freely expressed that if such modification becomes necessary the method should be known and clearly defined, so that makers of gears can adopt it and, if necessary, make their own cutters.

As pointed out in Mr. Flanders' paper and as mentioned repeatedly by our correspondents, the most desirable quality in gearing and the one by which it is almost universally judged, is quietness and smoothness of running. Next to this come strength, durability and permanence of form, and upon the last, of course, depend continued quietness and smoothness of action. Friction and journal pressure are of less importance, but still worth considering, and before reaching any conclusions from theoretical considerations alone, we propose to determine if possible, in a practical way, the relative advantages of some of the systems in common use and, with these, other systems to which we are disposed to give favorable consideration.

It is understood that the Institution would be pleased to have the coöperation of the society in the work they have in hand looking to a determination of the friction in the transmission of power by gearing. In this connection we have been reminded of a suggestion of Prof. J. Burkitt Webb, of Stevens Institute of Technology, made soon after the publication of the Sellers' experiments upon gears reported to our society in 1885. In these experiments an attempt was made to measure the friction loss between the teeth of a pair of spur gears, but the apparatus used, made originally for testing the friction of worm gearing, was not delicate enough for the purpose and the errors introduced exceeded, in some cases, the net result.

Professor Webb then suggested the possibility of so dividing one of the pair of spur gears to be tested as to make the load on the teeth self-contained. The apparatus which we have designed embodies this idea, thus making it possible to run gears under heavy loads at hign speeds with a very small consumption of power. We have also provided in our apparatus for an adjustment of center distance and means to measure the thrust between centers while the gears are running. Of course, the thrust between centers can be estimated very closely for involute gears from the pressure angle on the teeth, but we anticipate results somewhat in excess of this on account of the excess in friction of approach over that of recess, and, if any but involute gears are tested, it will also be interesting to compute from experimental data the effective obliquities of other systems.

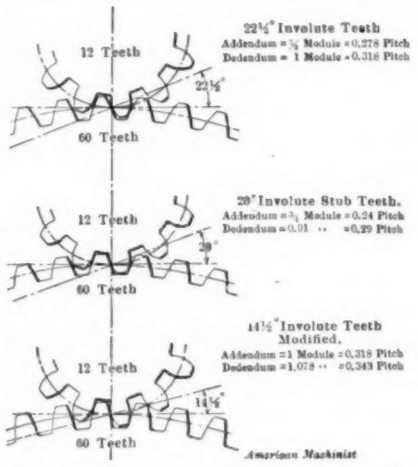


FIG. 4. GEAR TYPES TESTED IN MACHINE

We propose to determine the friction loss under various speeds and pressures for wheels and pinions cut to the Brown & Sharpe 14½-degree standard the 20-degree stub tooth and a 22½-degree tooth with addendum of ⅞ module or about 0.278 pitch. These gears will be tested at normal center distance, and also at distances about 1 per cent. or 2 per cent. of the pitch greater or less than this, and an effort will be made to record graphically the noise produced under these different conditions.

We believe that accuracy and permanence of form can thus be given their proper influence on the reduction of noise. It may take some time to determine the effect of wear, but from the method of loading the teeth and the small amount of power consumed some indication of the tendency of wear can be obtained. All gears tend to wear out of shape, and involute gears more so than cycloidal, but we recognize as a possibility that this tendency may be checked by the deformation itself and also that the loss in friction at different parts of a gear tooth is practically incalculable on account of the variations in friction for different velocities of sliding.

The experiments we propose should therefore give information unobtainable in any other way and throw a flood of light on the problem in hand.

As it is quite impossible for any of the committee, who are all busy men, to make the experiments here outlined, we have been fortunate enough to interest, through the intervention of Professor Lanza, of the Massachusetts Institute of Technology, two of his undergraduates, Messrs. Green and Doble, in making these experiments the subject matter for a graduating thesis. Professor Lanza hoped to have the work completed in June, so that the results might be communicated for discussion at our joint meeting in July, but this has proved impossible, partly because of the magnitude of the undertaking and partly of the delay in the completion of the testing machine.

Gear-testing Apparatus

The apparatus used in making these experiments is shown by Figs. 1 and 2, and the line drawing, Fig. 3, which gives some of the principal dimensions and shows the knife edges on which the machine rests. The machine consists of a frame *A* designed to carry a pinion shaft in roller bearings at one end, and a frame *B* pivoted to it and designed to carry the gear wheels *W* engaging with a wide-faced pinion *P* on the pinion shaft. The frame *B* is held to the frame *A* at its outer end by an adjustable clamping bolt *C*, and provision is made to measure the thrust on centers by means of the spring *D* acting between the frame *A* and an adjustable abutment on the frame *B*. The gear wheels to be tested consist of a central gear with a wide face and two side gears with narrow faces. The central gear carries two heavy cross pins *G*, which pass through

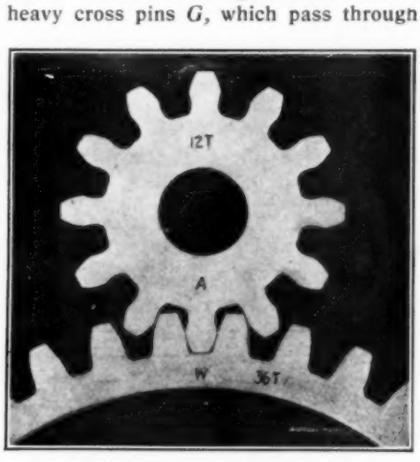


Fig. 5. Bilgram System; Pinion with Undercut Teeth

clearance holes in the side gears, and the side gears carry two heavy pins *H*, which pass through clearance holes in the central gear. Between the projecting ends of these pins *G* and *H*, heavy helical springs *S* are inserted, upon which pressure can be applied by means of the set screws *K*.

The pressure of these four springs *S* is resisted by the gear teeth, the middle gear pressing against one side of the pinion teeth and the side gears pressing against the other side. The pinion thus becomes simultaneously a driver and a driven gear and the power required to turn it when loaded in this way is only that required to overcome the friction of the teeth and whatever resistance there may be in the gear journals. The latter presumably is very small indeed, but provision has ben made to measure it by substituting plain cylinders without teeth for the gears and pinion, and running these under the same journal pressures. By deducting the resistance due to journals from the total resistance with running gears, the friction of the teeth alone can be determined.

In operation this machine is driven by an extension to the pinion shaft, carried to bearings several feet distant to permit of ample flexibility. The knife edge directly beneath the pinion rests upon a permanent support, and the other knife

Fig. 6. Bilgram System; Pinions with Increased Addendum in Mesh with Gear

edge is carried upon the platform of a small platform scales. The driving moment in the pinion shaft will therefore be measured by the scale reading at the end of an arm 20 inches long, and by reversing the direction of motion given to the pinion shaft the effect of any initial lateral strain in the driving shaft can be eliminated.

Types of Gears to Be Tested

Fig. 4 illustrates three types of gearing to be tested, and with these other types may be included later on.

Figs. 5, 6 and 7 illustrate a group of involute gears designed by Mr. Bilgram to engage a rack of 15-degree obliquity, and to demonstrate the possibility of using pinions of ten or even nine teeth with such a rack, provided the addendum can be varied. Without wishing to advocate the use of a variable addendum in interchangeable gearing, it is interesting to note the possibility of making a tentative solution of the problem in this way. A set of these gears has kindly been furnished by Mr. Bilgram for making a comparative test. He has also made a set of models, from which the figures have been photographed, and referring to them, he gives the following explanation:

"While the involute system of gearing has decided advantages over any other, it has the one disadvantage that the faces of the teeth of wheels come into interference with the flanks of pinions, if the latter have a comparatively small number of teeth. Unless the flanks of the latter are undercut, the teeth will interlock or at least mesh improperly.

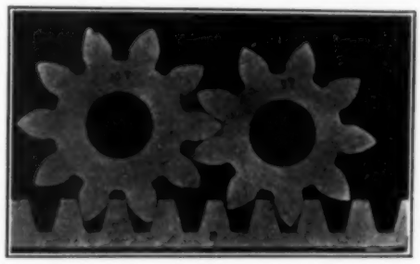


Fig. 7. Bilgram System; Pinions with Increased Addendum in Mesh with Rack

"In making a single pair of wheels, a remedy can readily be applied. There are two ways in which interference can be avoided, namely, either by increasing the angle of pressure or by shortening the addendum of the wheel. If the latter method is chosen and it is desired not to reduce the working depth of the teeth, it is necessary to add to the addendum of the pinion the amount taken from the addendum of the wheel.

"This latter method is out of the question when the problem is given to make an interchangeable set of spur wheels from a rack down to a 12-tooth pinion. This problem may be solved by a combination of both remedies alluded to."

The method consists of making racks and larger wheels with normal addendum, but increasing the addendum of pinions just enough to prevent the rack tooth from interfering with the flank. The samples presented (Figs. 5 to 7) consist of a rack *R* and a 36-tooth wheel *W*, with angle of pressure of 15 degrees and addendum equal to the modulus. The 12-tooth pinion *A*, generated by a rack, corresponding to rack *R*, shows the undercutting thereby produced. Obviously this pinion will not work, as so much of the involute is cut away that the path of contact is materially less than one pitch. But there are also shown pinions of 12, 10 and nine teeth, made with increased addenda. These were generated by a rack like *R*, but with a somewhat greater addendum than that used in generating the wheel *W* and a somewhat greater cutting depth. If these pinions are then mated with wheels of a large number of teeth, they will not enter as far as with pinions of equal number of teeth and have therefore a slightly less working depth.

On this plan may be based a system of involute gearing with a working depth of twice the modulus, and with a moderate pressure angle, 15 degrees in the samples submitted. Pinions of a small number of teeth will have an increased addendum, but a theoretically correct action is maintained. The pinion teeth have a wide base and are strong. One disadvantage in those cases in which pinions with less than about 24 teeth are embraced, is that the center distance is greater than that computed by the usual rule from the modulus and the number of teeth of the meshing wheels. Moreover, pinions will not have the full working depth when meshing with large wheels or with racks, but even in the case of a 10-tooth pinion meshing with a rack, the path of contact exceeds one pitch, so that at least for a portion of the action two teeth will be in contact simultaneously.

The plan proposed by Mr. Fellows is to use an involute with an angle of pressure of 20 degrees, and to reduce the addendum to ¾ of the modulus. Such teeth are known as "stub teeth." By this method interference in case of a rack gearing with a 12-tooth pinion is just avoided, and in the case of two 12-tooth pinions meshing with each other the path of contact is equal to about 1⅛ of the pitch.

Mr. Gabriel prefers the 14½-degree standard of the Brown & Sharpe Manufacturing Company.

The system which I propose is that of a pressure angle of 22½ degrees and an addendum of ⅞ of the modulus.

System Proposed by the Author

I believe that an interchangeable system of involute gearing, to be of the greatest value, should extend from a 12-tooth pinion to a rack, and in the selection of gears to be tested, we have chosen a 12-tooth pinion engaging a 60-tooth wheel. The maximum reduction with the maximum strength in a limited space, is the problem in gearing that generally confronts the engineer and a ratio of five to one is very often as much as he can realize without sacrificing too much strength. I recognize, of course, that the adoption of a larger number of teeth in the smallest allowable pinion overcomes some difficulties, and that this may be a debatable point, but I do not think any system of interchangeable gearing will be satisfactory which does not include pinions of 12 teeth. The cycloidal system formerly employed was based upon a 12-tooth pinion, and I believe this number can be retained for the smallest number in an interchangeable involute system without serious objection. That is, there is better ground for the retention of this minimum number than for a higher number and when the pros and cons have all been summed up there will be no change in this well established minimum for interchangeable pinions.

Although the experiments made under the direction of Professor Lanza are not by any means conclusive, enough has been done to indicate that the friction loss in gear teeth is influenced to a greater extent by the length of the addendum than by the obliquity of the system. Theoretically, the friction loss in involute teeth is independent of the obliquity and increases with the addendum. The loss in journal friction should vary as the secant of the pressure angle, but the latter is also affected by the dead weight on journals which even with plain bearings is a small matter, while with ball or roller bearings, it is a very trifling consideration indeed.

I believe, therefore, that a pressure angle of 22½ degrees can be adopted without fear of reduced efficiency in the transmission of power; that an addendum of ⅞ module will give an ample arc of action for all combinations of gears between a 12-toothed pinion and a rack, and that true involute forms made to these constants will avoid the necessity for any empirical modifications and give results comparable with the best now obtained by such means.

Results of Experiments Thus Far Made

Since the above was written, I have had an opportunity to make a short examination of the notes taken by Messrs. Green and Doble, and from these I have deduced results which may be given approximately as follows:

	Friction in Terms of Pressure.		
	In Teeth.	In Journals.	Total.
20° inv. ad. = ¾ mod.	0.008	0.002	0.01
22½° inv. ad. = ⅞ mod.	0.01	0.002	0.012
14½° B. & S.	0.0135	0.0015	0.015
Bilgram 15° special.	0.0215	0.0025	0.024

These figures are subject to some variation for speed and pressure and also to correction by Professor Lanza in his review of the work done by his students, but I believe them to be substantially correct within 0.001 or 0.002.

They are quite remarkable for the small percentage of power lost in friction as well as for the apparent effect of pinion addendum upon the loss sustained.

The 20-degree stub teeth with addendum about 0.24 pitch show less than 1 per cent. of friction on the teeth. The 22½-degree teeth with addendum about 0.28 pitch show about 1 per cent. of friction.

The Brown & Sharpe 14½-degree teeth with addendum about 0.32 pitch show about 1.3 per cent. of friction and the Bilgram special 15-degree teeth show over 2 per cent. of friction. In the latter case, the addendum of the pinion is increased considerably beyond that of the B. & S. standard and the addendum of the wheel is, of course, correspondingly reduced. The loss in effect from the long pinion addendum, however, preponderates over the advantage of a short addendum on the wheel with the resulting increase of loss in friction.

But in no case is the friction loss of sufficient magnitude to exercise a controlling influence upon the type of gear tooth to be recommended or adopted.

The loss in the teeth alone I believe to be much less than has hitherto been commonly supposed, and the high efficiencies obtained with teeth of 20-degree and 22½-degree obliquity should go far toward removing the prejudice which has so long resisted a step in the right direction toward the adoption of a pressure angle and an addendum which will completely eliminate interference between a 12-toothed pinion and a rack. When this has been done, there will be no necessity for any modification of the true involute form and we shall have a clearly defined system of gearing to which any of the methods of gear cutting now in use can be easily adapted.

Punching Small Holes

By G. H. Stevens

In making a large number of parts from 0.058-inch sheet brass a 0.04-inch hole was required. Drilling was too slow and punches were turned out of solid rod and the job done on the punch press.

A large number of punches were broken, and as they were rather expensive to make, various holders were tried, using drill rod, needles, etc., for punches. In these experiments an ordinary die plate with stripper and guide plate was used, but was not entirely satisfactory, as the punch was small, broke easily and wore the die as the comparatively thick metal forced it to one side.

The following plan has finally been adopted and seems in every way satisfactory:

The die consists of a bushing of any convenient size drilled about 0.004 inch larger than the punch and counterbored from the bottom to within 1/16 inch of the top of the bushing. A number of these may be made up and hardened at one time. The punch is an ordinary sewing needle, with the point broken off, held in a small Jacobs chuck, the shank of which is fitted to the punch-press socket.

The bushing is inserted in a plate or bar of cold-rolled steel, to which the stripper is attached.

The needles cost about three cents a dozen, the cost of the bushings is trifling and broken parts can be replaced in a few moments. Little or no oil should be used, as it may clog the punchings and break the punch.

Thomas A. Edison on Patent Reform

Editorial Correspondence

An interview with the well known inventor in which he discusses the hardships growing out of the present system and makes a few suggestions looking toward improvement.

In his interviews with business men and manufacturers throughout the country, the writer has encountered an ill-defined, but nevertheless positive feeling that the patent laws of the country are in great need of reform. While sound in the main, many details of procedure are considered to be unnecessarily burdensome and expensive to the legitimate inventor and manufacturer. Too much leeway is given to the business pirate who hovers about the outskirts of industrial progress, appropriating patented devices with a free hand, and depending upon the technicalities of court procedure to protect him in his ill-gotten gains. Mr. Edison, whose invention of the phonograph, the incandescent light, the kinetoscope and a host of other well known devices, has made his name a household word throughout the civilized world, was interviewed by the writer to get his impressions of the situation.

Mr. Edison stated at the outset that while he believed in our fundamental patent law and in our great Patent Office at Washington, he believed the details connected with their administration could be improved and the road made easier for the inventor who desired protection to recompense him for his labors and accomplishments.

Patent Office Examiners

Speaking of the Patent Office, Mr. Edison said that he had no fault to find with its administration and personnel. He believed the examiners were earnest in their endeavors to do what was right, but that they were laboring under conditions which were not conducive to the best results. American inventors have not only paid the entire expenses of the Patent Office, but also have piled up the enormous sum of nearly $7,000,000. Notwithstanding this, the Patent Office examiners are housed in an old fashioned building in cramped quarters, and hampered by lack of sufficient force to do the necessary work of classification which would insure a thorough search of the prior art. Besides, they are paid salaries far below what is paid in the business world for the same class of work. It is a well known fact that it takes several years for a man to become a proficient examiner. As soon as he has arrived at a state of proficiency, however, as often as not he is offered a larger salary by outside manufacturers and patent attorneys to enter their employ, which necessitates the training of new examiners, who, although of a high grade, are necessarily unable to perform their duties with the speed and proficiency of more experienced men.

The salaries of the examiners should be increased to such an extent and the method of promotion so regulated within the office that they will seek the service as a life profession, and not be compelled to look for sufficient renumeration and chance of advancement to outside business propositions. The wholesale resignations of examiners from the patent office are a matter of record and are altogether too frequent. These resignations hamper the work of the office and handicap the inventor. The more familiar an examiner is with a certain art the better is he able to assist the inventor by citing the most pertinent references against an application, thereby *enhancing the value of the patent* and enabling the inventor to get abreast of what has been done in that particular art and enable him to reach out for that which is new. Suitable provision should be made to enable the commissioner to build up and maintain an experienced corp of examiners.

Too Many Appeals

At the present time when a difference of opinion arises between an examiner and the inventor as to the scope of his claims, the law provides for two appeals within the Patent Office and an additional appeal to the Court of Appeals of the District of Columbia. Mr. Edison stated that he was heartily in accord with the bill before Congress to eliminate one of the appeals within the Patent Office and that he hoped the bill would become a law. These numerous appeals are not only expensive to the inventor, but are of great benefit to business pirates. This is true particularly in regard to seasonable articles which depend upon the whim of fashion and which must be marketed quickly to reap any benefit therefrom. An inventor of a small novelty, for example, files an application in the Patent Office which, in the crowded condition of work therein, owing to the insufficient number of examiners and the inexperience of many of them, takes at the very least, several months and often a year before becoming a patent. In the meantime, he places his device on the market and marks it "patent applied for." The business pirate thereupon proceeds to flood the market with a similar device and often unscrupulously files another application for the same device, which necessitates an interference proceeding with the application of the real inventor.

By the present procedure, it is possible to drag out this interference proceeding for several years, and by the time the inventor has obtained his patent, the demand for the device has diminished —possibly entirely ceased—and those manufactured by the pirate are in the hands of the user or of the small retailers throughout the country whom it is impossible to reach and who have purchased the device in good faith. It is understood, of course, that the inventor's only protection starts from the date on which his patent is granted.

Supervision of Attorneys—Change in Fees

A great help to Patent Office procedure would be to require that hereafter all patent practitioners must pass a rigid examination before being allowed to practise before the office. The standard should be raised and power given to the commissioner to limit solicitors to men of high standing and ability in the prosecution of applications. It is well known that many solicitors practising before the office are incapable. Some are doing a wholesale patent business, inveigling unsophisticated persons by clever and misleading advertisements to file applications on trivial and valueless devices with the allurement of the large rewards which sometimes accrue to inventors.

This practice can be stopped in the manner above pointed out and the inventor assured that when he takes his invention to an authorized solicitor of the Patent Office, it will be handled intelligently and that he will be advised honestly as to whether he should undergo the expense of prosecuting an application. This would not only aid the inventor directly, but would relieve the examiners from the burden of examining worthless inventions and poorly prepared applications, thus permitting them to spend more time where it is really needed.

Along this line a suggestion has been made that the fees for taking out a patent be rearranged in order to discourage the filing of trivial applications, the total cost of taking out a patent remaining the same, but the initial filing fee being made larger and the final fee correspondingly reduced.

Limit the Life of Application and Patent

Mr. Edison stated that another suggestion of which he approved was to limit

the life of a patent to a certain period *from the date of its filing*. At the present time it is possible to file an application and keep it alive, sometimes for ten or more years in the Patent Office until the art has grown up around and beyond it. The applicant then takes out his patent and lays an unfair and unjust tribute upon the industry of the country during the life of his patent. If the maximum life of a patent was made 20 years from the date of filing the application, with the further provision that if the patent issues within three years from the date of its filing, its life should be 17 years from the date of issuance, it would do much to obviate the abuse above pointed out.

The present commissioner of patents has attempted to obviate some of the above undesirable features, but is handicapped by the laws under which he operates. He has been able to get Congress to increase the salaries and is endeavoring to persuade Congress to provide a new building with suitable quarters, for his corps of examiners. He has improved also the internal administration of the office so that it is becoming more difficult to allow an application to lie inert for a long space of time, but positive relief will not come until the manufacturers and inventors of the country impress upon their representatives in Congress that immediate reform is needed.

Preliminary Injunctions Should Be Issued

Mr. Edison stated that the greatest need of the inventor and honest manufacturer was a radical change in patent litigation. Speaking generally, the system of conducting a suit in the lower courts is unnecessarily expensive and long drawn out. A quick adjudication to restrain infringers on a new patent, and a speedy determination of the patentee's rights, which shall be valid throughout the country, is much needed. Speaking first of a quick remedy against infringers, Mr. Edison vigorously contended that a preliminary injunction for the benefit of the original inventor should be granted at once on application. At present, a preliminary injunction is not granted unless the patent in question has been declared valid in some Federal court.

This condition of affairs is not fair to the inventor of a legitimate invention, as it takes several years to get a case to final hearing and the delay works untold hardships to American inventors. Either the courts should take time enough to go thoroughly into the question of preliminary injunctions, or the successful party to such a proceeding should be compelled to carry on the contested business under such direct supervision of the court or its officers as to prevent the wrongdoer from profiting in case it is determined finally that he is wrong.

Although the law provides for the collection of damages or of the infringer's profits if the patentee succeeds in his suit, it is impossible to get any adequate return owing to the sharp practices of the infringer. He can infringe a valuable patent, stave off a final decision, and make a good profit (which he carefully conceals) even after paying the expenses of the suit.

Hardships and Expert Testimony

We cannot get our patent cases litigated in any reasonable length of time and the inventor without unlimited capital is powerless. An infringer can delay the final hearing and pile up the expenses to a sufficient extent to ruin a less opulent opponent. The taking of testimony before notaries all over the country, who act simply as recording officers, is a great hardship. Such testimony ought to be taken before a judge or officer of the court under proper conditions of ruling and exception, in order to rule out the enormous mass of testimony which is now taken, and merely have that retained which is pertinent. This would reduce our records to a hundredth part of the space which they now require, with consequent savings all along the line.

The expert testimony which is taken in these cases is often of very little value and at the most, one expert on each side ought to be enough. As it is now, the patent experts at a fee of $50 to $100 a day testify for weeks, surrounded by lawyers, stenographers and the like, piling up an immense bill of expenses and occupying months and years, for which there is no adequate return to the inventor. And, after all, the testimony of the experts amounts to little more than sworn argument.

Court of Patent Appeals

Concerning a speedy final adjudication it would be a great help to have the cases passed up from the lower court to the appellate court more quickly than at present and an untold benefit would be the passing of the bill now before Congress to establish a court of patent appeals.

As illustrating the expense and delay which occurs in patent litiagtion, Mr. Edison recited his experience with his patent on the filament for the incandescent lamp. To sustain this patent required 14 years of litigation and the spending of more than $2,000,000. Even after it had been sustained broadly in several circuits, a Federal judge in another circuit refused to sustain it in his jurisdiction and his decision permitted a factory there to manufacture lamps which were bald infringements elsewhere.

The present bill before Congress, to establish a single court of patent appeals ought to be passed and would result in a tremendous saving to the industries of this country. At the present time a favorable decision in one of the nine circuits is not final in any of the others. An inventor after having been put to the expense and loss of time in having his patent sustained by an appellate court, should be able to use that decision with equal force and effect throughout the entire United States.

A Mixed Bench Desired

Mr. Edison was of the opinion, moreover, that this proposed court of patent appeals should consist partly of lawyers and partly of technical experts, say five lawyers and four experts. It would strike the average man as absurd to have a bench made up entirely of scientists to decide purely legal matters, and is it not just as absurd to have a bench made up entirely of lawyers to decide purely scientific matters? The lawyer is keenly interested in the fine points of the law and the technical expert is keenly interested in the fine points of scientific progress and invention. The inventors and scientists do not take much interest in legal opinions unless they directly affect scientific matters. Likewise, the legal man does not take much interest in scientific inventions and is not trained to consider them from a scientific and practical standpoint. Therefore, a mixed bench is what is needed in this court of patent appeals to enable the inventor to get a proper hearing and a just decision on the merits of his invention.

Two illustrations will serve to point out what is meant. In one of the hearings on the incandescent lamp, it was pointed out to one of the judges that an incandescent lamp was hanging over his head and had been in that place for over five years. He looked at it with unfeigned curiosity, remarking that he had not realized that it was anything new, but supposed that the light came from the usual gas burner. The second illustration points out the great difficulty in convincing the court that invention actually exists. When Mr. Edison's three-wire system was first exhibited in England with a statement that it saved 66 per cent. of the copper necessary for the wiring system, it was looked upon by electrical engineers as an absurd claim.

Proving Invention

In fact, a party of some 40 such engineers visited the exhibition and were extremely skeptical until one of their number actually took the trouble to figure out the basis of the claims which were being made and found they were correct. Some time later a Federal judge decided that the combination was so *obvious* as not to involve invention!

It is a characteristic feature of all good inventions that they are extremely

simple, and for that reason they are apt to be considered by the legal mind as being obvious; while a scientific mind, familiar with the art and with industrial development along that line, would at once see that the invention was the solution of a problem which had been long considered, and that the solution presented by the inventor, while simple and apparently obvious, was only reached after painstaking labor and the rejection striving to accomplish a particular result.

Mr. Edison stated that at one time he was working on a certain invention and striving to accomplish a particular result. He had worked for a long time without success, but felt that when once solved the solution would be so simple as almost to appear obvious. While working on this particular problem, Mr. Edison turned to his patent attorney, who happened to be present, with the jesting request that he invite a couple of Federal judges to visit his laboratory and point out to him the solution of his problem. He said he felt sure that after the result had been obtained it would seem so simple and easy as to appear obvious to them, and that, therefore, they could tell him offhand at once what to do, although at that time a large amount of work on his part had been fruitless.

Interest Must Be Aroused

In connection with the above, Mr. Edison said he realized that patent reform was an up-hill fight. Our legislators at Washington are overcrowded and apt to look upon the patent law as satisfactory until serious complaint is made. The fact that all such measures are non-partisan is one of the reasons why so little interest is taken in them. Another reason is that patent law is necessarily so technical in its nature as to be almost entirely unknown except to a comparatively small group of trained patent practitioners and our representatives naturally hesitate to undertake voluntarily the task of investigating it comprehensively and applying the needed reforms. For these reasons, inventors, associations of business men and manufacturers and, in fact, all who are interested in our industrial progress, should urge systematically upon their senators and representatives in Washington that the important bills above referred to should be passed and that with the least possible delay other bills providing the necessary reforms be framed and embodied in our statute law.

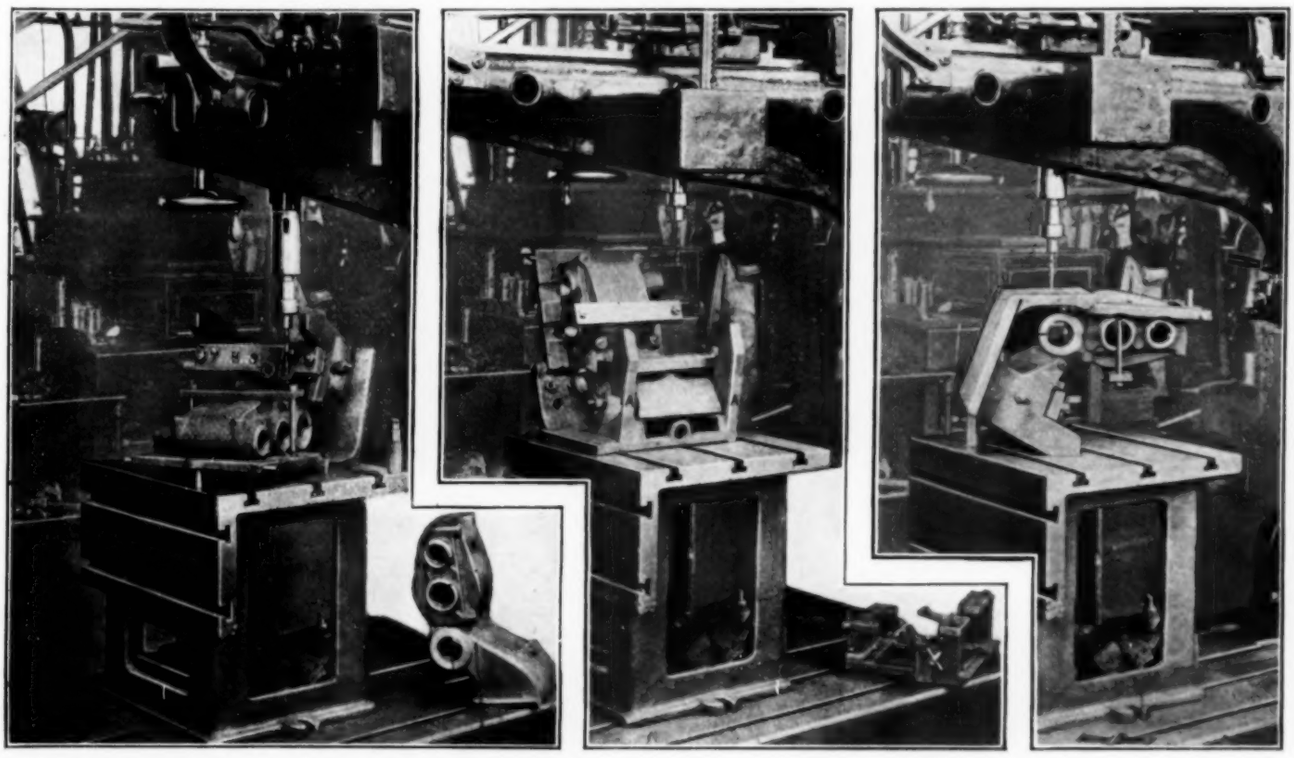
A Drill Jig in Grinder Construction

By Ulrich Steiner

Figs. 1, 2 and 3 illustrate the use of a drilling jig for the geared headstock. This jig is used in six different positions, the three not shown are one when resting on the surfaces *A A*, Fig. 2, and the remaining two when the jig is resting on its respective sides, which are machined, pins being provided in the upper end as resting places.

The cap *A*, which is shown fastened to the headstock, Fig. 1, is drilled in the jig resting on the base of the drill press, Fig. 2. Whenever a jig is in need of repairs or changes the department foreman indicates this by writing on a tag the necessary alteration and attaches it to the jig, as seen in Fig. 2. This notifies the tool-room foreman when the jig is returned to the tool room. The headstock when placed in the jig rests against its lips, as will be clearly seen in Fig. 2, laterally it is adjusted and held by set screws. The part *B*, Fig. 1, is provided with set screws, which, when tightened, hold the headstock to its bearings. The cap which was previously drilled is placed in its position as seen, and the holes for the screws in the headstock are drilled from it. After the holes are tapped the operator fastens the cap with a regular fillister-head screw, thus each cap is used on its respective headstock.

This method makes possible the best matching of the bosses and sides of the caps with the headstocks and has proved very satisfactory in the Landis factory.



Figs. 1, 2 and 3. A Drill Jig Used in the Landis Grinder Shop

Letters from Practical Men

Milling Machine Work on the Automatic Screw Machine

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

The sketches show how some jobs can be transferred advantageously from the milling machine to the automatic screw machine.

In Fig. 1 is shown a milling-machine job which formerly was made in four operations: Cutoff, mill slot, mill clearance and cut first corner, mill cut in second corner. When assembled, these blocks slide back and forth on a square shaft. It was decided to change the square shaft to a round one, and the slot now being half round, I suggested that the piece be made on the automatic screw machine.

Machining Two Bars Simultaneously

When I first set up the job, I intended to make the piece from one-half inch square stock, drill the hole and form the clearance slots, the piece to be sawed in half on the milling machine; but as I found that we had no half-inch square stock on hand, we stocked the machine with two bars of ¼x½-in. stock, hardly expecting it to feed properly. We were agreeably surprised to find that the machine fed double bars satisfactorily; in fact, as well as single ones. We had, therefore, doubled the production by making two pieces at one time, besides accomplishing a large saving in finishing the piece in one operation.

Fig. 2 shows the piece as made on the automatic screw machine. The slot at *A* was now on a circle, but this did not matter, as it was a clearance cut. Fig. 3 shows how the job was set up, the groove being formed by the cutoff tool *B*. The piece is drilled back in the chuck to prevent the two bars from springing apart.

The Operations

Following is the order of operations:

Just here I would like to say that I think that the above is a good example of expense saved, and many such cases would result, if the engineers when writing up operations for a new product would consult more fully with the screw-machine foreman, the punch-press foreman, etc., and get their opinion on the matter, for we have yet to see the man who is expert in all these lines.

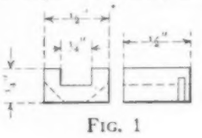


Fig. 1

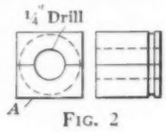


Fig. 2

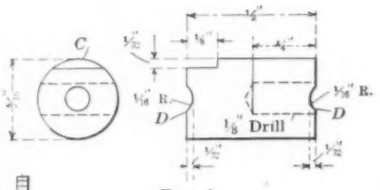


Fig. 4

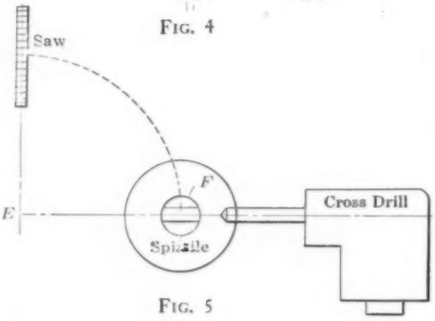


Fig. 5

The Screw-slotting Attachment

When the first order of operations for the piece shown in Fig. 4 was laid out, there were two things about Brown & Sharpe screw-machine work that were not considered. First, that the screw-slotting attachment would slot on one side of the piece as well as in the center, and second, that the screw-slotting arm described an arc of 90 degrees in operation, which feature would allow the flat at *C* to be milled or sawed parallel to the end slots *D*, these end slots to be drilled instead of milled.

The dotted line in Fig. 5 shows the path in which the slotting arm travels in carrying the piece (after it has been cut off) from the spindle to the slotting saw. *E* is the center of the slotting arm, and *F* the piece with the slot drilled in the end.

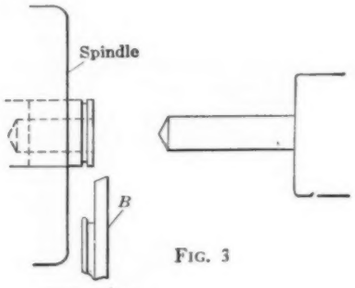


Fig. 3

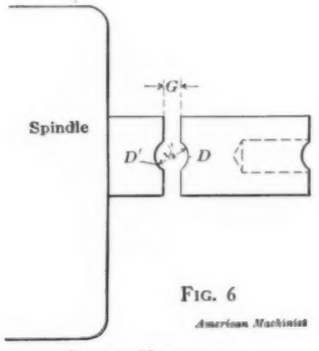


Fig. 6

American Machinist

Milling-machine Work on the Automatic Screw Machine

	421 revolutions per minute forward.	973 revolutions per minute backward.	Hundredths of Cam.
Feed stock to stop	243 revolutions	24 revolutions	3
Cutoff and form, 0.364" at 0.0015 feed		609	75
(Revolve turret 4 times)		(96)	(12)
Center 0.135" at 0.0056 feed		24	3
Revolve turret		24	3
Drill 0.510" at 0.0048 feed		106	13
Revolve turret		24	3
Total for two pieces		811	100

Rate of Production

This layout gives us two pieces in 50 seconds, or a gross production of 1440 in ten hours. The maximum surface speed of the stock is 90 feet per minute, and the maximum surface speed while drilling is 61 feet per minute.

The Original Method

The old order of operations was as follows: 1, screw machine, drill end hole and cutoff; 2, mill flat with milling machine; 3, mill slot in one end; 4, mill slot in other end. The present order of operations allows the piece to be made complete on the 00 Brown & Sharpe automatic in ten seconds. The material is 5/16 brass.

In explanation of how the end slots are drilled, I refer the reader to Fig. 6. After we have drilled the hole with the cross-drilling attachment, the cutoff tool, 0.062 inch thick, separates the work at *G*. This leaves a slot in the back end of the piece just made, shown by *D*, and a

slot in the front end of the next piece, shown by *D'*.

ORDER OF OPERATIONS.

	2400 revolutions per minute forward.	Hundredths of Cam.
Feed stock to stop	32 revolutions	8
(Revolve turret four times)	(128)	(32)
Stop spindle and cross drill, 0.385 inch at 0.0037-inch feed	104	26
Clearance	32	8
Center 0.062 inch at 0.0037-inch feed	14	4
Revolve turret	30	7
Drill 0.260 inch at 0.0037-inch feed	70	18
Revolve turret	30	7
Cut off 0.176 inch at 0.002-inch feed	88	22
Total number of revolutions for one piece	400 revolutions	100

Maximum surface speed of stock, 196 feet per minute.
Maximum surface speed of drills, 78 feet per minute.
Time for one piece, 10 seconds, giving a gross product of 3600 pieces in ten hours.

Time Comparison

When this piece was made the old way, it required 7 seconds for screw-machine work, and 11 seconds each for the three milling-machine cuts, averaging 40 seconds for one piece, or giving a gross product of 900 in ten hours.

Thus we have on this latter piece four times as great a production under new methods, not taking into consideration the time consumed in setting up the milling machines.

Cleveland, Ohio. S. H. Bacon.

Cutting a Spiral Groove in the Bench Lathe

Some clever devices for cutting spirals have recently appeared in the American Machinist. My attention has also been attracted to several other methods employed by different workmen. As these methods varied in degree of simplicity, I was prompted to devise something original for cutting the spiral slot in the work shown in the drawing.

All of the elements composing the combination seen here are regular excepting the master and segment. For cutting the threads in the master an ordinary parting tool, the cutting end of which formed part of a 0.10-inch circle was used while the segment was bored and formed to a diameter somewhat larger than the bottom of the threads in the master. It was then sawed through the middle and shaped as shown. The upper end of its shank was slotted and the segment was sweated in. The shank was fitted to the T-rest (this being bolted directly to the bench-lathe bed), and was secured with the set screw shown. Although a spring could have been placed in the T-rest to support the segment, it was not necessary. Both master and segment were hardened in oil, and after placing in position, the slight irregularities were lapped out, thus insuring smooth movement of the spindle, which was actuated by hand through the nurled knob shown.

For convenience of illustration I have shown the milling attachment swiveled, but the same result is obtained more conveniently by swinging the slide rest and cutting from the top. This also does away with the necessity of having a swiveling milling attachment. In either case the setting angle can be approximately found as herewith illustrated.

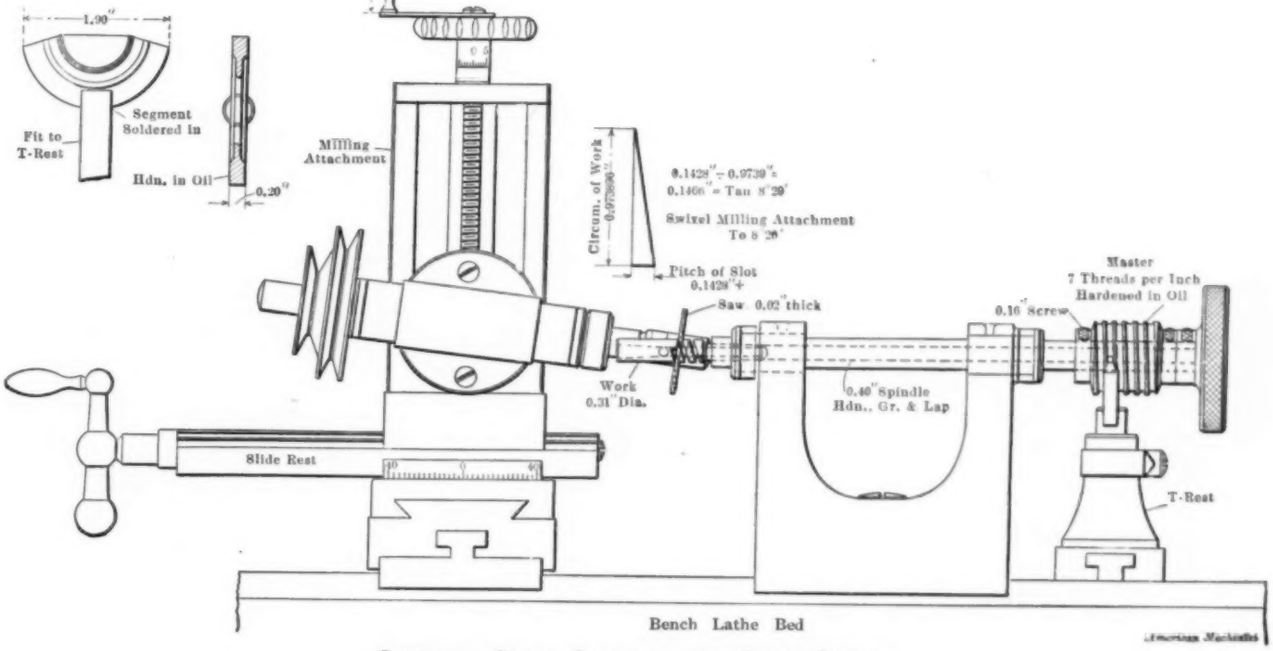
Elgin, Ill. Gus. Haesseler.

Coolant or Lubricant

Regarding the question of coolant or lubricant, I would ask the following questions: How is a coolant useful on such slow work as ratchet drilling? Why won't any oil do for this work, or why are some oils more useful than others? Why is graphite of any use?

With regard to the first question, I put forward the following incidents: I was ratcheting a ¾-inch hole in some steel, real tough stuff, and started off without any lubricant to the drill. The job did not progress as well as I thought it ought and so I poured some mineral lubricating oil on the drill point. This helped matters somewhat and the drill cut a little better and fed easier. I then tried linseed oil, and the result was all that could be desired. Less pressure was required for feeding and the drill took less pulling round, and when it is an "armstrong" motor providing the power this is important.

Again, I was threading a screw with a die which did not have the proper clearance, so that the thread was partly cut and mostly squeezed to shape. Used at first with mineral oil, the thread was rough and cut almost to a knife edge. About half way through I changed to linseed oil and the rest of the thread was



Cutting a Spiral Groove on the Bench Lathe

smooth and of full section. It was also noticeably easier work pulling the die round.

Now, I admit that my experience is limited and not very precise, but it has convinced me that, in some cases, at least, the action of the fluid is that of a lubricant. I have tried graphite cycle-chain lubricant when drilling tough steel and found it made the work considerably easier. I happened to have a tube of this lubricant lying about, and remembering the article in the AMERICAN MACHINIST about graphite in thread cutting, I tried it quite as an experiment and found it answered admirably.

It occurred to me that the main difference of action is this: When the metal is cut by a tool which has plenty of cutting clearance and at such a speed as to be liable to overheat the tool, then a coolant is more necessary than a lubricant. When, on the other hand, the metal is cut by a tool without sufficient clearances, and when the cutting is slow, then a lubricant is required rather than a coolant to lubricate the passage of the chips and the work past the tool.

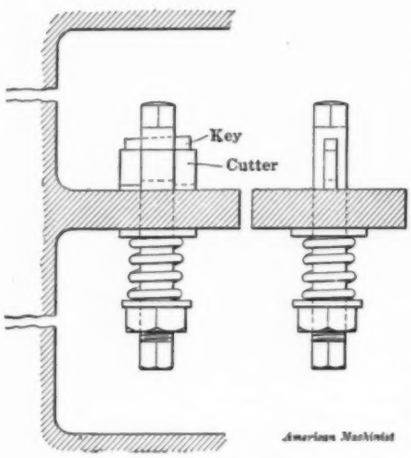
I am using the word "clearance" in rather a loose way to denote clearance from the chip, i.e., top rake, as well as in the usual sense.

Perhaps it may be as well to mention that linseed oil is unsuitable for general use, apart from its cost. It is because after exposure to the air it oxidizes, thickens and finally becomes quite gummy. Still, for bolts or pipes which are likely to get rusty before use, the oil which would remain on them after threading, etc., would serve as a protective coating and so would not be entirely a nuisance.

London, Eng. R. SAVORY.

A Special Facing Tool

The sketch shows an old device which may prove new to some of your readers. We use it for facing around holes for cap screws, where it is impossible to use a drill press or an upside-down facing



SPECIAL FACING TOOL

tool. It has a square on both ends and a tap wrench fits it so it can be turned by hand. The spring keeps up the tension until a good face is secured.

Pearl River, N. Y. JOHN RAMSAY.

An Efficient Expanding Eccentric Mandrel

The attached blueprint is a drawing of an expanding eccentric mandrel used at the Clinton, Iowa shops of the Chicago & Northwestern Railway. This mandrel will take all standard eccentrics from 6½- to 9-inch bore and 4½-, 4¾-, 5-, 5¼-, 5½- and 5¾-inch throw. The different throws are obtained by shifting plate *B* on plate *C*. The rib on plate *B* and grooves on plate *C* allow the placing of plate *B* in four different positions on *C*.

The six ⅝-inch holes in each plate are numbered for a certain throw and by bringing the two holes with the same marks together and placing the ⅝-inch bolt in these, the mandrel is set for that throw. The holes are placed in the plates so it is impossible to put two holes of different throw together.

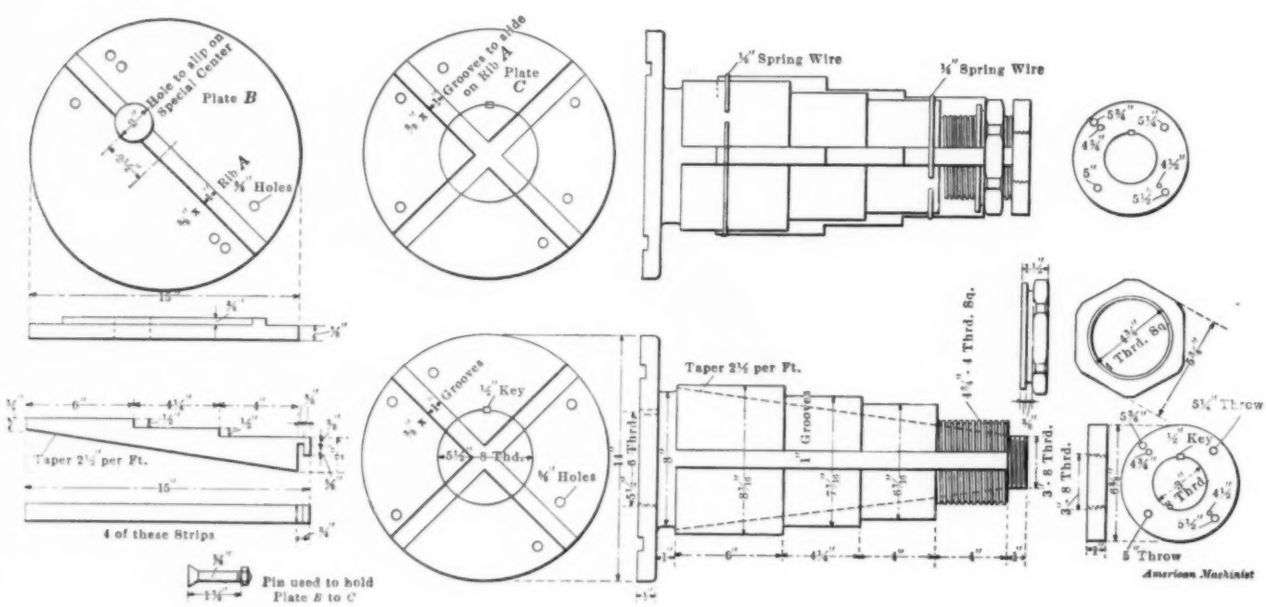
The mandrel is centered on the lathe faceplate by a special center which fits the 2-inch hole in plate *B*, and is held to faceplate and driver by two clamps which also hold it in place while the tail center is removed to place an eccentric on or off.

Clamping the mandrel on the faceplate makes a very solid and steady drive and an advantage over old-style mandrels swung on centers, which would wear, causing the throw to become longer or shorter and the eccentric to run out sideways.

This mandrel was designed by Otto Godiskesen, who deserves credit for its success.

Clinton, Ia. CHARLES MARKEL.

The American Society for Testing Materials has drawn up standard specifications for various materials, which are now being voted on by its membership. These include standard specifications for Staybolt Iron and for Yellow Pine Bridge and Trestle Timbers. It is also considering a proposed Standard Method of Testing, which seems to have many desirable features.



AN EFFICIENT EXPANDING ECCENTRIC MANDREL

Discussion of Previous Question

Shop Organization Problems

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

On page 1067 of the AMERICAN MACHINIST there appeared an article entitled "Shop Organization Problems," embracing questions of shop organization, economy of operation, depreciation of equipment and other questions more or less of a financial character; all pertaining to machine shops and small manufactories.

Some of the questions brought forward no doubt involve considerable thought and study before being definitely disposed of, and even then it is quite possible that local conditions will, to a certain extent at least, be the determining factor.

The financial questions, however, can and should be decided by the board of directors or the finance committee, if there is one, and they need not be influenced in any way by the conditions in the shop.

A great deal of friction and discord, always detrimental to the success of the business, follows the interference with the operating management by either of these bodies, neither of which, as a rule, know anything about the practical running of a shop. The first general subject taken up in the above mentioned article is:

INSPECTION DEPARTMENT

It seems that the first question to be determined here is whether the quality of the work turned out of a machine shop using piece-work and premium systems of payment is any better than that from a shop where regular daily wages are paid. If it is not any better, then there can hardly be any doubt as to the advisability of maintaining an efficient and thorough inspection department.

While it is very probable that the quantity of work done is greater than under the former systems, nevertheless, this fact in itself would tend to prove that the quality of the work would be inferior, especially if the quantity done under the piece-work system very greatly exceeded that done under the old one of daily wages.

It is not the purpose of this article to decry or criticize piece-work methods, for in the majority of cases they are far more equitable both to employer and employee than any other.

The great advantage is that the employer pays each man for just the work he does, or, in other words, just what the man is worth, it being understood, of course, that the rates fixed are just to both parties. It would hardly be fair, however, to pay the same rate to two men, one of whom operates a new, uptodate, automatic machine, while the other struggles along with one only fit for the scrap pile.

It is quite natural that a man, who is paid according to his output, is apt to rush the work along as fast as possible and put the responsibility as to quality up to someone else, yet it will hardly follow that the elimination of the inspector will in any way remedy this difficulty. The responsibility will only be moved along a step and put up to the management, and no doubt the error or defect will be discovered about the time the article is to be shipped.

Any feeling of antagonism between the workman and the inspector is usually caused by one or the other going beyond his limit, as it were, and the moment this feeling becomes evident, one of them will try every way possible to get the best of the other and *vice versa*.

No man likes a spy, therefore, if an inspector wishes to be treated right and have his work made easy for him, he should feel that he is a help to the workman, rather than a hindrance and obstacle that must be gotten around at any cost. The moment anything wrong is noticed, he should promptly take the matter up with the proper person and not wait until the job is about finished before calling attention to it.

On the other hand, should the operator notice a defect in a casting, he should promptly call the attention of the inspector to it before doing any machine work. An inspection department that is fair in its dealings and at the same time firm in its decisions, is no doubt a good thing for any shop, and if it is properly managed, the workmen will soon learn to respect it and know that all work must be done right.

DEPRECIATION

The author of the article previously mentioned is no doubt correct to a certain extent in his ideas regarding this subject of depreciation.

There is one thing, however, he seems to have lost sight of, viz., improvements in design, material, etc., in the newer machines, which always tend to lower the value of the older ones, no matter in how good a condition the latter may be. The automobile business may, perhaps, be cited as a fair example of this fact. No one will pay the same price for a 1909 model as for a 1910, even though neither of them has been used.

In making an inventory it is, therefore, necessary that the appraiser be thoroughly familiar with the market price of latest designed machines, as well as with the value of the improvements on the newest, over the ones to be appraised. In this way, by making a comparison between the two, it should not be so very difficult to arrive at an equitable figure. When it is borne in mind that the market price of any article involves not only the actual cost of manufacture plus profit, but also delivery, terms of payment, etc., it will readily be seen that there are really only two factors to consider, namely, the market price of the new machine and the condition and age of the old one.

It is, of course, quite possible, in fact probable, that some years the valuation will be greater than for the previous one, but this would be due only to better business conditions, when premiums are paid for quick deliveries. Should the appraised machinery be disposed of during such times, no doubt the prices set for each machine would easily be realized.

THE SINKING FUND

Any manufacturing concern, be it large or small, that creates, maintains and increases a surplus or sinking fund, rather than pay out all of its profits to stockholders in the form of dividends, will weather all storms of adversity with little difficulty. As the fund increases, the value of the stock will increase, as will also the respect of the banks with which it does business. It will also help out in taking care of an unusually large job that requires more ready cash than perhaps is available, thus making it unnecessary to go to the banks for accommodations. It will also be of service in taking advantage of some unexpected offer of discounts for cash on bills payable. In fact, a fund of this kind is of such value that wherever possible it should exist, even in the smallest shop owned by a single individual.

Of course, it must not be understood that the fund is for promiscuous use, as

with regular working capital, or very likely it would soon be all gone. Whenever any amount is withdrawn from it, proper account should be kept and the amount taken out, with interest at the current rate, should be returned at the first opportunity. In other words, let the sinking fund be the banker. Some concerns have found it highly profitable to invest a part of the surplus earnings in high-class bonds which would be easily negotiable in time of need.

ASSESSMENTS

There is a great difference between having a sinking fund and making an assessment on the stockholders for the purpose of renewing the plant. In the former case the money is already at hand, while in the latter it is sometimes well nigh impossible to get the stockholders to pay up. They will hem and haw and say that the renewals are not needed, and that the old machines are plenty good enough, and even use as an argument the large dividends they have been enjoying on their stock, not realizing that these dividends will soon dwindle away to nothing if the plant is not kept up. One so often hears the cry of lack of funds for repairs and renewals on the part of the management, that if by any possible means the stockholders can be induced to create a surplus fund and add to it periodically, it should be done. It not only helps the management to take advantage of every opportunity for larger profits, but it also creates confidence.

Pittsburg, Penn. EDWARD BROWN.

Electric Hoist Gearing Efficiency

Relative to S. H. Libbey's article about the efficiencies of electric-hoist gearing, beg to submit that the reasoning in lower part of column 1, of page 953 is open to argument.

Mr. Libbey says that the observed average efficiency of the whole gearing mechanism, from pinion to load, for a single-thread worm, is 45 per cent.

He further quotes F. A. Halsey as stating that the worm drive alone for the thread angle and pitch-line speed in question is 82.5 per cent.

Under these conditions the writer will assert that the efficiency of the drive, other than worm drive, is

$$\frac{45 \times 100}{82.5} = 55 \text{ per cent.;}$$

not $82.5 - 45 = 37.5$, as stated by S. H. Libbey.

Similarly, for double-thread worm

$$\frac{52 \times 100}{90} = 57.7 \text{ per cent.;}$$

not $90 - 52 = 38$, as stated.

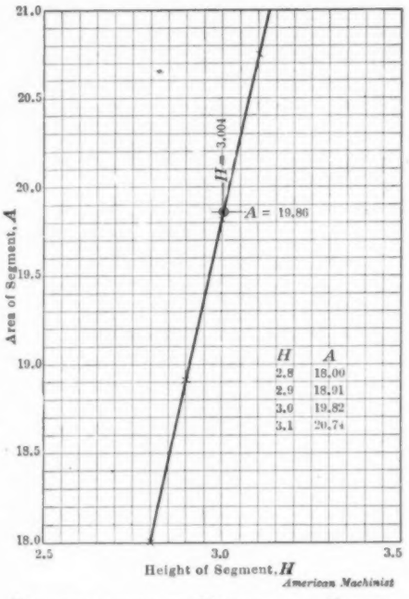
This calculation being based upon fundamental mechanical principles, it is hardly necessary to occupy space proving it. I shall here only hint that, mathematically speaking, efficiencies are quotients, while effect losses, figured in horsepowers, are items which, for a given transmission, are to be added to obtain the total loss.

OLAV HELLELAND.

Grass Valley, Cal.

Area of a Segment

A problem which necessitated the finding of the depth of water to give a certain volume in a partly filled, horizontal tank, caused me to try for an easy way to determine the hight of a segment of a circle having a certain desired area, when the diameter of the circle is known. This attempt very quickly resulted in a collection of sines, cosines and other



INTERPOLATING BY MEANS OF A CURVE

things too complicated for comfort, so I looked for some other way to solve this problem.

One way to do this is to resort to the ever-handy engineers pocket-book, almost all of which contain tables for the finding of segment areas, when the diameter and rise are known. Of course, this is not solving the problem directly, because it requires a book or table, but I am safe in assuming that few people are sufficiently acquainted with the tables of sines and cosines to get them from memory, so that the use of the book should be excusable.

On page 116, of Kent's Mechanical Engineers Pocket-Book is a table of areas of circle segments. This table gives values of versed sines and the area of the segment corresponding to this function, in a circle having a diameter of unity. The instructions for using this table are given as follows: "Divide rise, or hight of segment, by diameter, to obtain versed sine. Multiply area in table corresponding to this versed sine by the square of the diameter." The result of this operation will give the area of the segment desired.

The problem is, of course, the reverse of the above, but this is very easy to work. The tank in the problem was 10 feet in diameter by 28 feet long, and we wished to know how deep the water should be to give a volume of 4160 gallons. Then, the segment area on the head must be

$$\frac{4160}{7.48 \times 28} = 19.86$$

square feet. Consulting the directions for the table mentioned, it will be observed that dividing this area by the square of the diameter should give an area corresponding to some versed sine in the table. The diameter is 10 feet, so dividing by 100 we have 0.1986 square feet. Now, entering the table, we find an area 0.19817 corresponding to a versed sine 0.300, and also an area 0.19908 corresponding to a versed sine 0.301. The value, therefore, which we desire, is between these two and may be obtained by interpolation, giving a versed sine 0.3005.

This versed sine should be the hight, or rise, of the segment divided by the diameter; therefore multiplying by the diameter, 10, we have the hight, or rise of the segment, 3.005 feet, which is the answer desired, or the depth of the water in the tank to contain 4160 gallons.

Should anyone object to using the table, and desire to work it out mathematically, there is another method. This process is to guess at a probable hight, figure the area, and then guess again, getting a new area. A very few attempts would give enough figures to plot a curve between hight and area of segment, and if this is drawn to a sufficiently large scale, it is extremely easy to read.

This process is illustrated in the accompanying line cut and the small table in this cut shows four points on this curve which could be figured by the regular formula for segment area. These points were then plotted and the line, which is practically straight, was drawn as shown. The original scale of this drawing was very much larger, so that it was possible to read to four significant figures very easily. The result obtained for the hight of segment required to give an area of 19.86 square feet in a 10-foot circle was shown by this curve to be 3.004 feet, which is sufficiently accurate for all practical purposes.

As the curve of variation between H and A is so very nearly straight, ordinary interpolation would have been easier than plotting the curve in this case, but the principle will work just as well should the line have a much greater curvature, and may, therefore, be applied to many useful purposes.

New York. R. S. BAYARD.

A Proposed Tooth Gearing Standard*

By J. D. Steven†

There is need of an interchangeable involute-gear tooth standard, particularly for the finer pitches. A system is proposed having a pressure angle of 20 degrees and an addendum one-quarter of the circular pitch.

*Presented at joint meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers.

†Associate member, Institute of Mechanical Engineers.

The subject of gearing is one which has received a considerable amount of attention in recent years. Numerous articles have appeared in the technical papers and suggestions have been made on different methods of cutting wheels, and on various modifications for proportions of teeth. The views expressed have not so far resulted in any marked uniformity of opinion, and it is with the hope of opening such discussion that will lead to more uniformity that this paper has been written. The cycloidal shape has not been considered, the involute being in most general use.

Modern Necessity for Accuracy

The following remarks are intended to apply more particularly to gears of comparatively fine pitches (from say the smallest up to 4DP or 3DP), for, although they may be capable of wider application, it seems to the author that the advent of the automobile, and to some extent of the steam turbine, has created the necessity for the finer pitches being cut with greater accuracy than was considered either possible or necessary up till 12 or 15 years ago. The automobile manufacturer has steadily raised his standard of quietness since the first gears were fitted to, the author believes, a Panhard car in about 1895 or 1896, until the present time; and during the last two years the advent of the piston-valve engine has necessitated all other parts being made practically noiseless. With the steam turbine also there has arisen a demand for smooth-running, high-speed gearing to drive pumps, tachometers, etc., and now that attention is being given to the question of using gearing on turbines to reduce the speed for ship propulsion, there is likely to be an increased demand for accurate wheels in the near future.

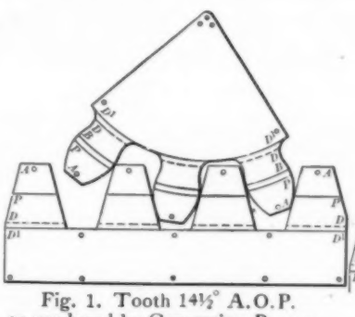


Fig. 1. Tooth 14½° A.O.P. as produced by Generating Process. (Brown and Sharpe.)

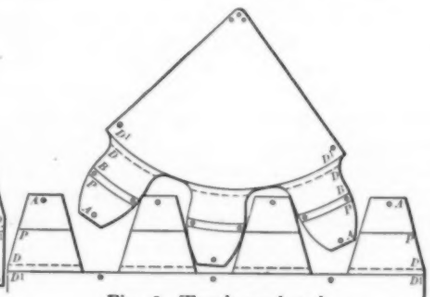


Fig. 2. Tooth produced by Rotary Cutter. (Brown and Sharpe.) American Machinist

Gear-cutting Machinery

A vast amount of ingenuity has been expended in the design of machines to produce gearing of the accuracy required, and the work turned out from many of them could hardly be improved upon. In considering the merits of these machines, however, one is inclined to ask why so many of them should cut forms of teeth more or less different from each other. On the whole, the differences are slight, but they are often sufficient to prevent smooth rolling between the gears. It may be of interest to consider briefly a few of the principal makes of gear-cutting machines, particularly with regard to this variation in tooth shape produced by them, and their ability or otherwise to produce teeth of the same shape.

Bevel Gears

For cutting bevel gearing there is little doubt that the generating machine has largely superseded the type working with a former.

Machines with Formers

These machines produce not a true form of tooth, but one which is adjusted to do away with undercut, like that produced by a Brown & Sharpe rotary cutter. The formers are to some extent a source of trouble, as slight differences in their shape will cause difficulty when different numbers of teeth have to roll with each other. The advantages of these machines are that they are very stiff in construction and therefore speedy, and that a strong form of tooth is produced, which rolls in many cases quite satisfactorily enough, particularly for differential pinions, which do not run continuously, or at a high speed. The first cost, too, is generally less than that of a generating machine.

Bevel-generating Machines

The best known at present are the Bilgram bevel-planing machine and the Gleason generating-bevel planer. These machines are capable of cutting all gears within their capacity with true forms of teeth, so that they will roll satisfactorily with each other. Increased angle of pressure can be produced and proportions of teeth (depth, etc.) altered at will on either make of machine. From the purely machine-shop point of view the first cost is high and they require skilled attention to keep them in thorough order, so that a simpler type of tool might be more suitable where such skilled attention was not available. The gears from these two machines can be made interchangeable with very little trouble, and a high degree of accuracy can be attained.

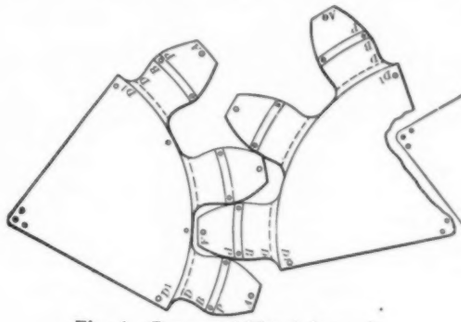


Fig. 3. Generated Tooth in mesh with Single Cutter Tooth. (Brown and Sharpe.)

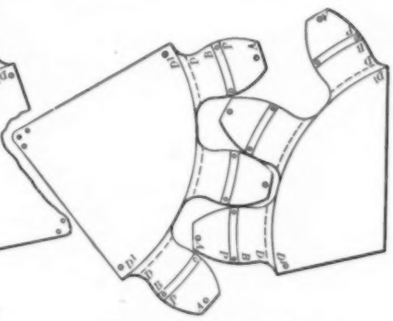


Fig. 4. Teeth as in Fig. 3 but in different position. American Machinist

Spur Gears

For cutting spur gears, there are three principal methods, namely, by rotary cutters, generating, planing and hobbing. For the first method the Brown & Sharpe machine is probably the best known, and with cutters accurately made, exceedingly satisfactory gears are produced. How-

ever, all gears having below 30 teeth, if made to the Brown & Sharpe figures, are undercut below the pitch line to provide for clearance of the engaging teeth, as will be seen in the diagrams later on, and as undercut cannot be produced with a rotary cutter, an amount of adjustment is required in the shape, which affects the teeth rolling with those produced by other methods. If the standard tooth shape can be so altered as to allow of a reasonably small number of teeth being cut without alteration to the true form either above or below the pitch line, there is no reason why the single-cutter method should not continue to hold its own with any others for some time to come.

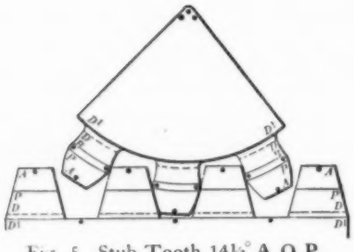


Fig. 5. Stub Tooth 14½° A.O.P. in mesh with rack.

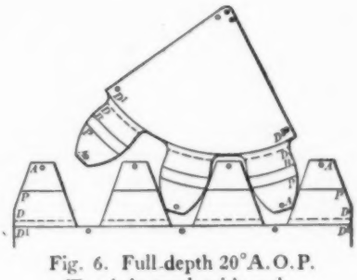


Fig. 6. Full-depth 20° A.O.P. Tooth in mesh with rack.

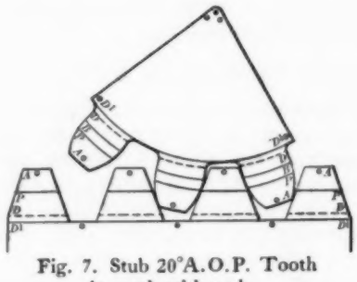


Fig. 7. Stub 20° A.O.P. Tooth in mesh with rack.

Spur-generating Machines

Among generating machines the Fellows gear-shaper and the Reinecker spur-gear planing machine are well known. The Fellows forms the teeth with a cutter which corresponds to a pinion of the same pitch as the gear being cut. A very satisfactory tooth is so produced, but with the standard form of cutter metal is removed below the pitch line and the tops of the teeth are left practically square, so that they do not roll satisfactorily with those cut by the Brown & Sharpe methods. An advantage in this machine is that gears can be cut close to a solid flange, sufficient clearance only being necessary to allow cuttings to get away from under the tool.

The same reasons as the above prevent teeth cut on a Reinecker planer from rolling with those cut on a Brown & Sharpe machine. The Reinecker is, however, a very ingenious machine, planing the teeth with a flat-sided cutter exactly as a bevel planer does, and the angle of pressure can be varied in particular cases.

Hobbing Machine

The hobbing process, which is, of course, really a generating one, has of late years come much into favor and with well made hobs very satisfactory work can be done, at least as rapidly as on a Brown & Sharpe machine. In a paper read before this institution by Thomas Humpage, at the meeting in July, 1908, some of the advantages and disadvantages of this method are stated. The principal advantages claimed are speed and greater accuracy; and the disadvantages, the production of flats on the gear teeth due to the spacing of teeth in the hob, and a tendency to leave their points too thick. The first objection causes trouble in certain cases, but the last objection is hardly a real one, as it can be overcome by slightly modifying the shape of the hob tooth.

The principal difficulty from the machinist's point of view is that unless he can produce gears from a hobbing machine to roll with others, its use is at once limited. It is fairly easy to make a hob which will cut teeth of a Brown & Sharpe shape, but these will not then roll with those cut by generating methods, so that a double or even larger stock of hobs would have to be kept to meet all cases. This alone is a serious item of expense in days when most tools are made of high-speed steel, costing anything over 1s. 6d. (37 cents) per pound.

Worm-gearing Machines

Worm gears are usually made by cutting the worm on a lathe or special thread-milling machine, and the wheel by feeding a taper hob past its diameter at the proper working centers. In some cases a straight hob is used which is fed into instead of past the wheel. In neither case is the shape of tooth affected by the machine used, so that the importance of the merits of different machines from this point of view does not arise.

Advantage to Machine Shop of Uniform Tooth

It is evident from a brief consideration of a few typical gear-cutting machines, that any change in tooth proportions which would enable any of them to be used with equally successful results, would be welcomed in many machine shops. At present it is often the case that two or three machines can stand idle, while the heap of blanks grows larger instead of smaller round others which have produced the first few gears and must cut the remainder for the sake of interchangeability. Before advocating a change in the standard form of tooth, however, it is necessary to consider it carefully as affecting (1) the supporting and housing of the gears, (2) the strength of the teeth, and (3) the amount of contact surface and any other proportions which go to make a smooth-running wheel. Unless we can satisfy the user of the need for change, the machinist's troubles are unlikely to influence opinion as to the best form. In speaking of users, it may be interesting to note here that of six leading automobile firms who were asked their opinion on the standard tooth, two believed a change necessary, two gave a qualified reply to the effect that they sometimes departed from Brown & Sharpe shape, and that they always thought there should be more cutters to a set, and two others were satisfied with the present state of affairs.

As it is obvious that we must do away with undercut in our tooth if we are to cut gears at all with a single milling cutter, and get the full strength where it is required, namely the root, an increased angle of pressure seems to be the first alteration desirable. But increased angle of pressure increases the load on the bearings, which, carried to an extreme, would be a substantial reason for remaining as at present. If, however, an increase from 14½ degrees to say 20 degrees or at most 22½ degrees will satisfy the conditions, there are few cases where bearings could not be made to safely take a load greater by 5 per cent. or 6 per cent. than before.

Again, if the first alteration is to increase the pressure angle, we at once increase the strength of tooth by broadening it at the base, so that there can be no objection on this score. If, then, as they appear to the author, these are the two slightly extraneous points likely to arise in considering the effect of a new shape, they are not difficult to dispose of, and there is no reason why the matter cannot be considered solely with a view to arriving at the best shape for general purposes.

Models of Teeth

In order that the subject of tooth dimensions and proportions might be examined, there has been recently made at the author's works a number of card-

board models with teeth carefully laid out full size. A table is used having a straight-edge fixed to one side, and against this is laid a cardboard rack. A segment of a pinion of twelve teeth is fixed on a center at the proper working distance, and a sheet of glass laid over the whole. By moving the rack along the straight-edge the points of engagement of the teeth can be most satisfactorily observed. The rolling of the segments with each other is arranged by fixing them on pins at the proper centers. They can then be moved round under a glass plate and their contact, etc., in different positions, noted.

The diagrams, Figs. 1 to 8, inclusive, are produced from photographs of such models. In all the diagrams the principal parts of the teeth are lettered thus: (A) addendum points; (P) pitch line; (B) base line; (D) working depth; (D^1) whole depth.

Table 1 shows particulars of the models which were used. The large pitch was adopted so that the differences in the various forms could be more clearly seen.

	14½ degrees.	14½ degrees.	20 degrees.	20 degrees.
	Ordinary.	Stub.	Ordinary.	Stub.
Number of teeth in pinion	12	12	12	12
Circular pitch	12.1661	12.1661	12.1661	12.1661
Diametral pitch	0.2582	0.2582	0.2582	0.2528
Pitch diameter	46.471	46.471	46.471	46.471
Outside diameter	54.216	52.553	54.216	52.553
Base-circle diameter	44.988	44.988	43.668	43.668
Working-depth diameter	38.726	40.389	38.726	40.389
Whole-depth diameter	37.509	39.172	37.509	39.172
Standard thickness		6.083		
Chordal thickness		6.066		
Addendum	3.872	3.041	3.872	3.041
Dedendum	4.481	3.650	4.481	3.650
Depth	8.353	6.691	8.353	6.691

TABLE 1. DETAILS OF GEAR TEETH.

Brown & Sharpe Tooth

Fig. 1 shows a 14½-degree angle rack and engaging with it a 12-tooth pinion laid out correct to figures, and with no correction for undercut. This is, of course, the tooth which would be generated by a hob or by other form of generating machine if the tool was not altered to prevent the base of the tooth being so weakened. From this diagram the amount of undercut necessary in a 12-tooth pinion to enable it to clear the points of the rack teeth is clearly evident, and the sudden change in form of tooth just below the pitch line is somewhat startling to anyone who has not so far had the necessity or inclination to consider the subject.

The rack tooth immediately to the left of the center line is seen with its point just meeting the pinion below the pitch line, and shows why the clearance is required.

In motor-car back axles, where it is quite common to have 14 or even 12 teeth in the bevel driving-pinion, this weakening of the base of the tooth is of increasing consequence, as the tendency increases to have a higher horsepower than the nominal. If the gears are cut on a generating machine the tooth can only be strengthened by adopting a greater angle of pressure.

Fig. 2 shows the standard Brown & Sharpe tooth as it would be produced by a single circular cutter. Here the flanks of the teeth are radial and give greater strength at the base. The amount of rounding off on the rack tooth is seen in this diagram, this being required, of course, to clear the part of the pinion tooth below the pitch line. With a pinion as shown, it is obviously necessary to round off the points, not only of rack teeth but of the teeth of gears containing any larger number of teeth than the pinion has when they are required to run with it. The amount of this rounding is, as stated in Brown & Sharpe's own treatise on gearing, to be determined more by experiment than by rule. It introduces an uncertain quantity into the work of laying out gages, and certainly removes, coupled with the radial flanks, a great part of the proper form of the tooth.

Fig. 3 shows an attempt to run a generated gear with a Brown & Sharpe standard. It can at once be seen that

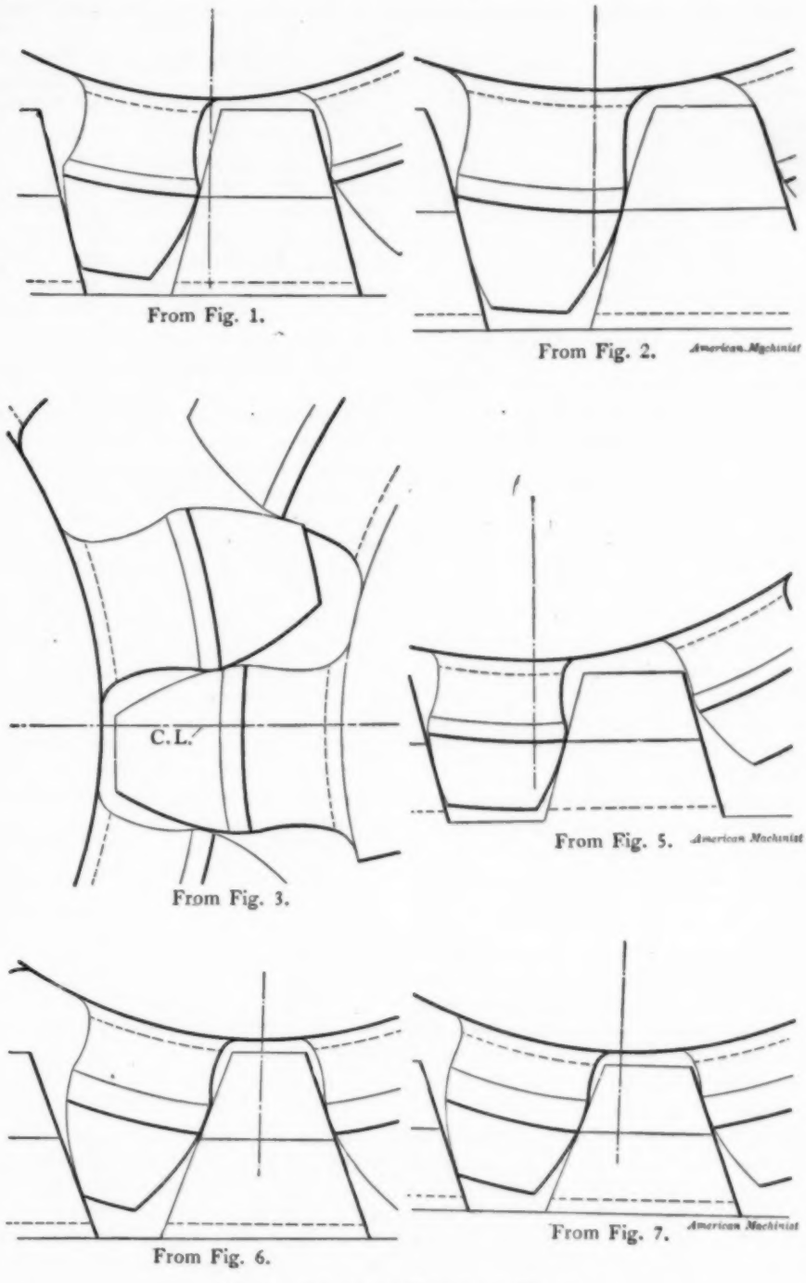


FIG. 8. ENLARGED VIEWS OF TEETH

the point of the generated tooth on the right-hand pinion is overlapping the other and would have to be considerably rounded, in an actual gear, before it could be made to run.

Fig. 4 shows the same two gears in a different position with relation to each other. The points of the outer teeth on the Brown & Sharpe pinion are some distance away from the flanks of the generated gear, so that the load is all on the one tooth.

In Fig. 5 is shown a form of short or "stub" tooth engaging with a straight-sided rack, the angle of pressure being 14½ degrees; while this appears to be, and to some extent is, stronger than the Brown & Sharpe tooth of standard depth, there is still undercut, and this will be required in "stub" teeth in any proportions so long as the 14½-degree pressure angle is retained.

Increased Angle of Pressure

Having seen the limitations of the tooth with 14½-degree pressure angle, it is worth considering whether an increased angle will result in a better form for universal adoption. While, as already pointed out, a slight increase in bearing pressure cannot be a very serious objection in most cases, there is no object in increasing the angle, and consequently pressure, more than necessary.

In Fig. 6 is shown a tooth of standard depth, but with an angle of pressure of 20 degrees. It will be noted that the undercut is very slight, so that it would disappear in a gear of a few more teeth than the pinion shown.

We can now increase the angle by a few degrees, or endeavor to dispose of the remainder of the undercut by other means. Having reached the required result so nearly by an increase of only 5½ degrees angle, and consequently an increase of about 5 per cent. load on the bearings, it may be better to leave this proportion as it is; or, on the other hand, it may be better to still increase the angle, and leave the other proportions alone. The author is inclined to favor the former alternative.

In a paper read by Wilfred Lewis before the Engineers' Club, Philadelphia, in 1900, an increase of pressure angle to 20 degrees or even 22½ degrees is advocated, but the depth remains unaltered. In a pamphlet published by the Fellows Gear Shaper Company in 1907, a 20-degree is advocated, with a short or stub form of tooth. Here we have a difference of opinion in two quarters where consideration has been given to the subject, and so long as such differences exist it is difficult for the ordinary user of gearing, with probably but a slight interest in such questions, to decide on the best form for his work.

It is well to remember that in teeth such as the Brown & Sharpe 14½-degree angle the larger the number of teeth running together the less is the contact, owing to the rounding of the tops, and whereas when a tooth is used of such proportions that the correct shape requires no alteration, there is no decrease in contact with larger numbers of teeth.

In the teeth under consideration those with 14½-degree pressure angle would have rather more contact than the 20-degree stub form, were it not that the undercut extends above the base line, and so interferes with the contact. As at about 25 teeth the proper working curve will not be interrupted in this way, its length with 14½-degree angle, and ordinary depth, is 0.175 inch greater than with 20 degrees and stub depth. In small numbers of teeth the stub contact is actually the greater, and in all numbers of teeth the proportions of working curve to total is much greater.

Fig. 7 shows a pinion with such teeth in mesh with a rack. This tooth is advocated by the Fellows Gear Shaper Company, but its method of fixing the depth seems unnecessarily complicated. It advocates having a 4-pitch tooth with 5 P depth, and 5 P with 7 P depth, a 6 P with 8 P depth, and so on, the depth in every case but the 4-pitch being that of a pitch No. 2 finer.

As module and various odd pitches have to be dealt with, a more general method of fixing this dimension would be, in the author's opinion, an advantage, and to take one-quarter of the circular pitch as the addendum in each case is a much simpler thing to remember. The difference is not much between this and the Fellows depth.

The following figures show what the difference is on a 6-P gear:

	Fellows. 6/8P.	Author. cP/4.
Addendum	0.125	0.1309
Dedendum	0.1562	0.1570
Whole depth	0.2812	0.2880
Thickness	0.2617	0.2618

or a difference of 0.0068 in the whole depth.

Worm Gearing

While no investigation can be complete which ignores this important form of gearing, the author feels that it is quite impossible to deal with it in the scope of a short paper. So many worm gears are now being used in automobile work, and so much difference of opinion exists as to efficiency, angles of pressure, globoid and straight worms and other points, that it is to be hoped the latest practice may be the subject of a paper by someone fully able to deal with it, at an early date.

Conclusion

The author is well aware that this paper contains nothing very new on the proportions of gear teeth, but, as stated in the beginning, his object has been to bring the subject before the members, so that if possible some uniformity of opinion may eventually result. Such uniformity would undoubtedly be most welcome to everyone who has either to cut or use gearing to any extent.

He also feels, as stated in the early part of this paper, that conditions have so radically changed during the last few years, there is every reason to consider the question now with an open mind, and in the fullest possible manner. If a new form of tooth is desirable, it is his opinion that the stub form with 20-degree angle of pressure would be a change in the right direction, because:

a. It can be used right down to 12 teeth in its true form, and cut on either a single cutter or generating machine.

b. It is altogether a stronger form than that most commonly used at present.

c. A very large proportion of its face does useful work.

d. The possible objections on the score of less contact and greater bearing pressure are so slight as to be nearly negligible.

He Could Break Lathes but Not News

By M. H. Westbrook

I had a newly arrived Scotchman working for me on a large triple-geared lathe.

He came to me, looking very solemn, the other day, saying, "There's a tooth broken out of the large gear in my lathe."

"Well! take this order to the repair man and have him insert a tooth. In the meantime you go and run lathe No. 8."

"But there are also six teeth out of the pinion."

This being more serious, I asked how it occurred. He did not know but thought something must have fallen in the gears.

"Well!" said I, "better make a good job of it. Here is an order for a new pinion. Now look after this job yourself and get it rushed through as I must have the lathe by Thursday." This was Tuesday.

"But the extension arms which hold up the back-gear spindle are both broken," said he.

And upon investigating I found both bearing arms broken off close to the headstock. And it took a patternmaker and two machinists six days' hard labor to get it repaired.

There is no moral that I can see in this. But looking at the occurrence from a distance, it seems funny the way he broke the news to me.

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American Machinist

Editorial

Perpetual Motion Again

We are in receipt of a pamphlet put out by the Indiana Power Company, of Indianapolis, Ind., explaining the operation of the hydrodynamo, which is an undisguised perpetual motion, and soliciting subcriptions to the stock of the company.

This case differs from most others of its kind in that the pamphlet gives engravings of the machine and what purports to be an explanation and analysis of its action, the tone and temper of which are entirely honest. We are, therefore, constrained to believe that the promoters of the enterprise are self-deceived into the belief that the machine is based upon sound principles, and the more so because the explanation of the action of the machine is sufficiently clear to enable anyone versed in the elementary principles of mechanics to detect the point where their reasoning fails and to show why the machine cannot work.

As a matter of fact the machine is mechanically worse than most others of its kind, because it is not even in theoretical equilibrium, but, supposing it to be frictionless, it would require a constant application of power to keep it in motion.

While the explanation of the mechanical action of the machine is reasonably clear, of sections of the pamphlet on "The Principia of Energy," "Examples of Physical Phenomena" and "Technical Announcement Engineering Office of Indiana Power Company" so much cannot be said. These abound in the fog which normally surrounds explanations of perpetual-motion machines and leads one to wonder what possible state of mind the author could be in to write or to believe that any reader could understand them.

Following are a few gems from the section on "The Principia of Energy":

"Transmuted energy is attracted to and manifested through natural transmuting media suitable to the characteristic dynamics of the force in which it is manifested.

"Any force transmitted through a natural medium may be either conveyed therefrom in its original form of energy upon leaving such medium, or may be transmuted upon entering the medium to the cognate or paired anti-force, and retransmuted to the original force upon leaving such medium.

"Energy brought in the form of any natural force into an artificial translating medium is partially carried through same in its original form and partially disseminated by by-production in other transmuted forms of energy.

"Therefore, dissemination, or so called waste, of energy may only take place through artificial translating, and not through natural transmuting media."

One of the pities of the enterprise is that the machine is now being constructed in the shops of the Winona Technical Institute. That students in a trade school should be given a perpetual-motion machine to make and thereby be encouraged to believe the making of such a machine to be a worthy and serious enterprise is a reflection upon those responsible for the taking of the work, which needs no comment.

The Wright Patents

There is a movement on foot, promulgated or perpetrated by one of the popular magazines for the "patriotic" purpose of having Congress purchase the Wright brothers' patents for any sum possible not exceeding one million dollars, and present them to the people of the United States and to the world.

This is based on the assumption that the Wright patents cover the basic principles which make aviation possible, and that without their use the development of our new accomplishments and industries must cease.

We hardly believe that the Wright brothers will be particularly pleased at such a proceeding, which seems to make them the recipient of the nation's bounty in place of a fairly earned return for their labors through the practical development of a legitimate business. The decision of the court will decide on how much the Wright patents really cover, and if it be found that such patents as are sustained are not necessary for aviation, the proposed purchase would be more in the nature of a gift than a justly earned remuneration. If, on the other hand, the patents are fully sustained, we have every reason to believe that the Wright brothers are broad enough to accept reasonable royalties which would not

in any way hinder the development of the industry.

The United States Government had an opportunity of buying the Wright patents several years ago, and for a much less sum than one million dollars; but as it neglected the opportunity, we do not believe that it will be seriously considered again. Nor do we believe such a precedent is entirely without danger, and the whole proposition seems to be better designed to secure publicity for the magazine in question than to seriously aid the development of aviation.

Delayed Deliveries of Accessories

The results of delayed deliveries of machine tools and other products are more far-reaching than we sometimes imagine, and are among the penalties we pay for boom times. It is bad enough when you are unable to deliver a machine as expected and promised, owing to some unexpected delay in your own shop, but when you finish the machine as agreed and have the delivery hung up several months because the motor is not forthcoming, you are dangerously near the elastic limit of patience.

Nor is this all, for if your customer cancels his order, as he has a perfect right to do when your contract is not fulfilled, it may be disastrous to you in the case of a special machine, and through no fault of your own.

There is room for some practical diplomacy along this line, so that while a man is held strictly accountable for his own delays, he is not liable to lose through the delays of others over whom he has no control. No machine builder wants to refuse to supply a motor because of the fitting or mounting which makes it a part of his machine, and most customers prefer to make one contract instead of two. For this reason they look at it as one job and do not take into account the delay of any part as separate from the whole, knowing that in too many cases it has been used as an excuse to cover their own delays.

What is wanted is a form of contract which will put the responsibility for delay where it belongs and not compel an innocent builder to suffer for the delay of others. Penalties help in some cases, but it often happens that the builder of part specified by the customer will not take an order in that way.

While it is easy to say that the builder should insist on prompt deliveries, it is more difficult than it sounds. And the machine-tool builder has delays enough of his own, without holding him responsible for those which occur elsewhere.

Motors have been used simply as a convenient example, not because they are the only things which delay shipments.

Steering the Boys of Boston

That a man's success depends on his choosing a suitable vocation, and that most men choose blindly are two statements that must be accepted as equally true. That so many men make successes of their lives under these circumstances speaks well for the elasticity of human nature.

In Boston an attempt is being made to guide school children into fitting channels by making a study of their psychological natures as well as their physical qualities. The responsibility which these people take upon themselves in guiding young people in ways which may mean lives of happiness or misery is great, so great that we imagine the country as a whole will be slow to follow Boston's example. At the same time the whole country will watch Boston's progress with the greatest of interest.

We do not understand that it is expected that fine distinctions can be made. For example, it is not likely that any boy will be told that he should become a patternmaker rather than a carpenter, but he might be told that he would make a better wood worker than lawyer. Even then, if his future life showed that he made a good carpenter he might always blame the bureau that advised against his becoming a lawyer. Many men would rather be fifth-rate lawyers than first-rate carpenters, out of love for power and show of authority. The fact that a person may earn the most money at any given occupation may not make him satisfied with that occupation. The love of power or the love of ease may predominate, and again there are people of a philanthropic turn of mind who prefer to work at something at which they cannot draw large pay, simply for the good which they can do. Teachers, experimenters, social workers, all come under this class.

In this new scheme the choice of vocation is supposed to be made at the close of the public-school life, which averages close after 14 years of age. Up to that time, education has been supposed to be absolutely general, not fitting for any vocation, but covering general information likely to be of value to anybody, and also a large amount of work of no particular value except as mental discipline. Mental discipline is supposed to stand in a similar relation to the brain that a card index does to a library. It enables a person to immediately store away a fact in a certain part of his brain and to quickly bring forth that fact when wanted. There is no possible doubt that our public schools aid greatly in this training and make it possible for their graduates to absorb information much more rapidly than their grandparents could. The advocates of the "mental discipline" method of instruction affirm that it matters little what instruction or what subject is used, so long as the mind is brought to a given state of discipline. If they can bring a person's mind to that state, they assert, then, that person can go forth into the world and learn any trade or vocation without the aid of a school at all, thus doing away at one fell swoop with trade and professional schools. So far they have been in the state of the Keely motor—almost ready to run.

This latest step is one more intended to steer the young mind in the channel of least resistance, so that the previous mental discipline may reach forward in its most efficient way.

We shall watch the experiment with interest.

A Gear Hobbing Machine—Erratum

In the last paragraph of the article describing the Meisselbach-Catucci gear-hobbing machine, on page 228, occurs the obvious error, "small brass gears . . . 0.004-inch face." This should be 0.040-inch face.

Obituary

Stewart W. B. Menzies, master mechanic of the Yukon Gold Company's machine shops at Ogilvie Bridge, Dawson, Y. T., was instantly killed, July 10, by the falling of a 3-ton bull wheel of one of the dredges which was in the shop being repaired.

American Society of Engineer Draftsmen

The object of the above organization, founded on June 18, 1910, is the advancement of engineering knowledge and practice, and the maintenance of a high professional standing among its members. The principal means for this purpose will be the holding of meetings for the reading and discussion of professional papers and for social intercourse; the maintenance of an engineering library; the maintenance of an employment bureau for the exclusive benefit of members, with all obtainable data relative to conditions governing employment in the various drafting rooms throughout the country.

The officers chosen for the first term are: President, E. Farrington Chandler, vice-president, Wm. B. Harsel, and secretary-treasurer, Henry L. Sloan, with headquarters at 116 Nassau St., New York City.

New Tools and Shop Appliances

A Combination Cam and Valve Grinder

Fig. 1 shows a grinder built by the Bay State Grinder Company, Worcester, Mass.

The machine carries two 12x1-inch wheels, mounted on interchangeable collets which permit the operator to change wheels quickly and with the assurance that they will run true, providing they were true when removed from the machine.

To the left in Fig. 1 is shown an attachment for grinding gas-engine cams; an enlarged view of this is also shown in Fig. 2.

Figs. 1 and 2 show a single cam being ground, but two cams can be ground at once, providing the combined lengths of the hubs do not exceed 3½ inches.

Two arbors, with No. 4 Morse taper shanks and ground to correspond to any size cam shaft, are furnished with each attachment.

The master cams are generated by grinding from approved models furnished by the customer.

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

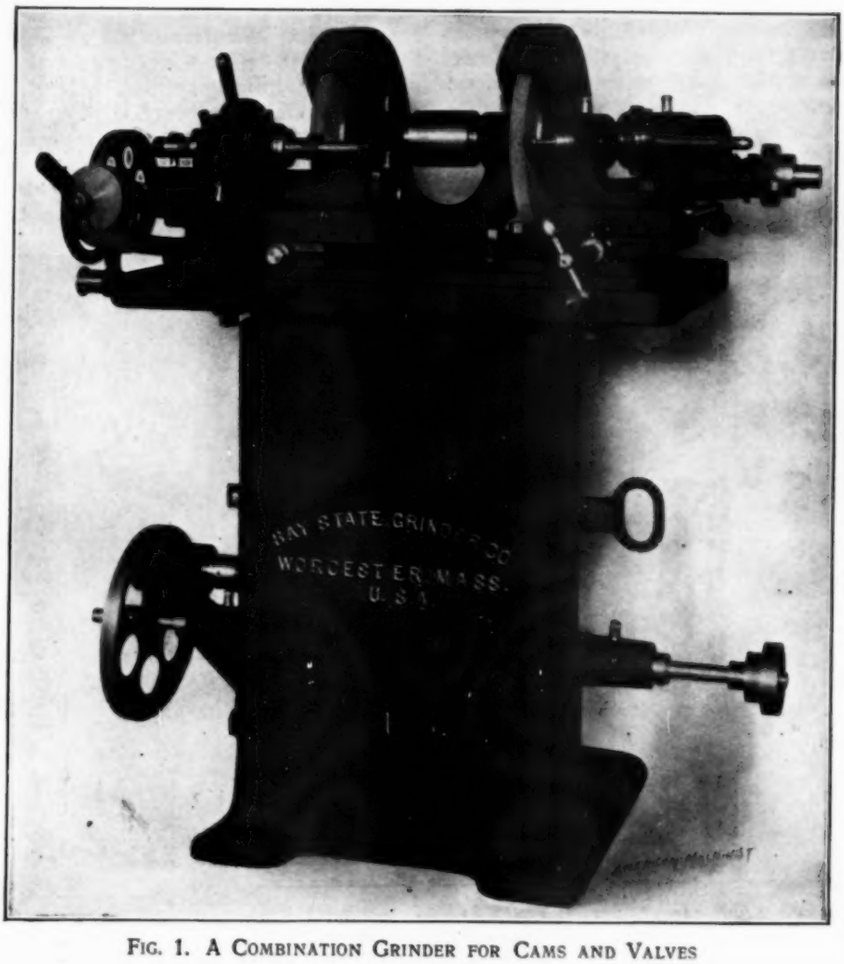


FIG. 1. A COMBINATION GRINDER FOR CAMS AND VALVES

In order to grind rough cams to the model, the master pattern rotates against a hardened-steel plate which is turned to the same size as the wheel; as the wheel wears down, another guide plate the same size as the wheel is turned into position, for the master cam to rotate against, and so on until the grinding wheel is worn out.

The traverse of the table is operated by the connecting rod shown, and can be varied to suit the different styles of cams, the traverse being limited to 3½ inches.

Fig. 3 shows a valve-face grinding attachment having a hardened and ground spindle fitted with a draw-in chuck.

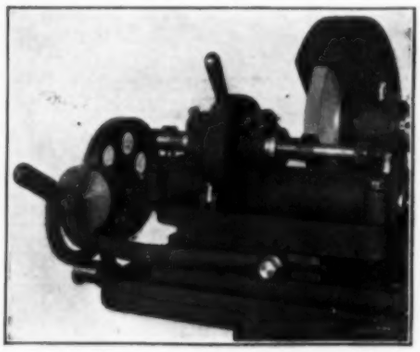


FIG. 2. CAM-GRINDING ATTACHMENT

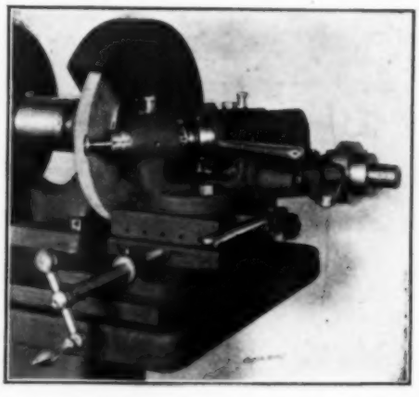


FIG. 3. VALVE-GRINDING ATTACHMENT

This attachment will grind valves without using center holes. The valve stems should be ground to a limit of 0.001 inch to insure accurate grinding of the faces.

This attachment is regularly made for a face angle of 45 degrees, but can be furnished for any angle.

A special attachment to grind valves on centers is also made.

The cut represents the grinder with two heads—one for grinding cams and the other for grinding valve faces.

The attachments are detatchable from the table, so that the machine can be fitted with one of each attachment or two of either, or with the integral cam-grinding attachment, so that the complete out-

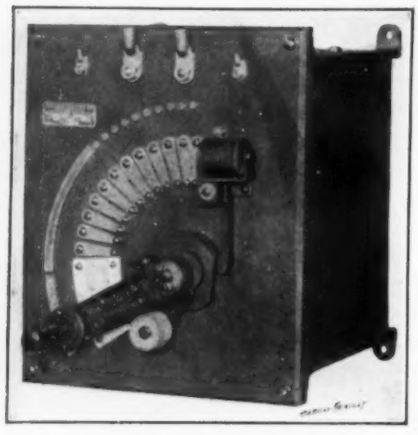
fit can be used, if desired. Although not shown in the cuts, this machine is now regularly fitted with water attachment.

The spindle runs in adjustable bronze bearings. The countershaft is on the back side of the base of the machine.

The machine weighs 1250 pounds, and is fitted with belts, also with diamond holders, one for each attachment.

Speed Controllers for Machine Tool Motors

The General Electric Company, Schenectady, N. Y., has designed a new rheostat for machine-tool service where full-load current is taken at lower speeds in order that the motors may maintain a constant torque. These permit a 50 per cent. reduction in speed by armature control and a 25 per cent. increase by field control.



SPEED CONTROLLER FOR MACHINE TOOLS

They are provided with a no-voltage release attachment for protection from failure of voltage and the consequent danger of power being again thrown on the line without resistance in series with the motor armature. Upon failure of the voltage, the retaining magnet is demagnetized, releasing the arm, and a spring instantly returns it to the off position, making it absolutely impossible to close the armature circuit without cutting in all the armature controlling resistance. The no-voltage release coil is connected directly across the line in series with a resistance, and is thus independent of the current of the motor field and will protect any motor with which this rheostat may be used.

Machine Shop Furniture

The use of machine-shop furniture is becoming more and more a necessity in the modern shops and not only adds to the general neatness, but aids in reducing fire risks.

The illustrations shown are among the latest devices brought out by the Western Tool and Manufacturing Company, Springfield, O. Figs. 1 and 2 show two positions of a toolmaker's vise stand. This will ordinarily be used as shown in Fig. 1, but to hold work in unusual positions, the side attachment shown on the shelf in Fig. 1 is clamped in the hole, and the supporting stem of the vise is

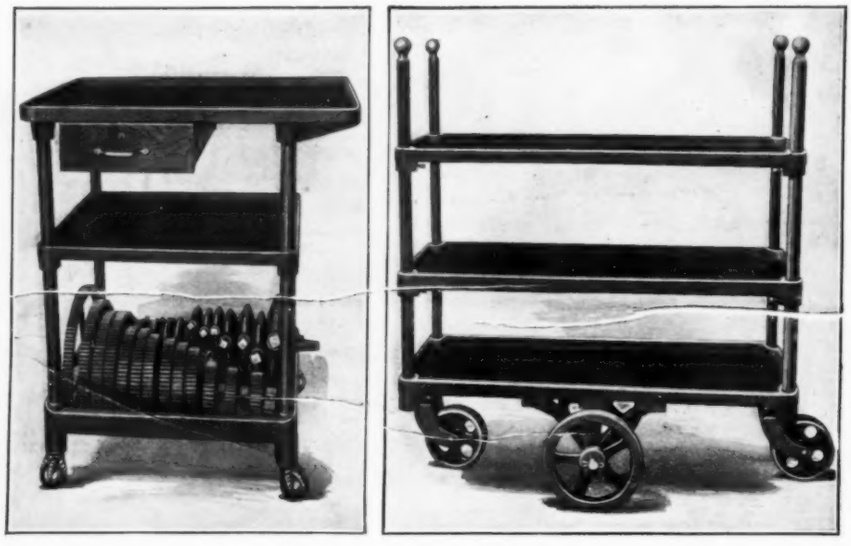


FIG. 4 PORTABLE SHOP STANDS FIG. 5

FIG. 1. TWO VIEWS OF TOOLMAKER'S VISE STAND FIG. 2.

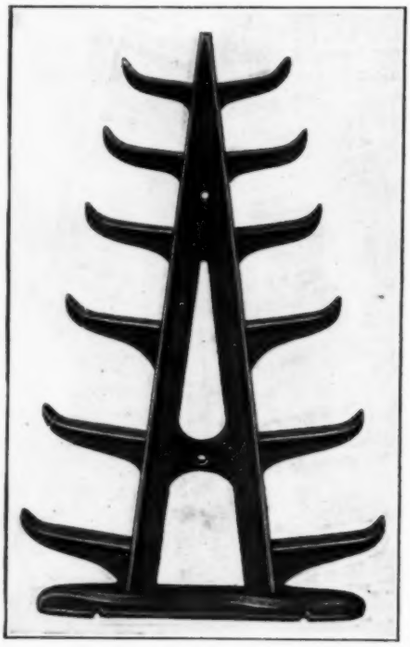


FIG. 3. COMPACT STEEL RACK

then held as indicated in Fig. 2. This attachment allows the vise to be swung into any position desired.

Fig. 3 shows a compact and convenient rack for holding twelve different sizes or kinds of steel. Other uses will also be found for a rack of this kind.

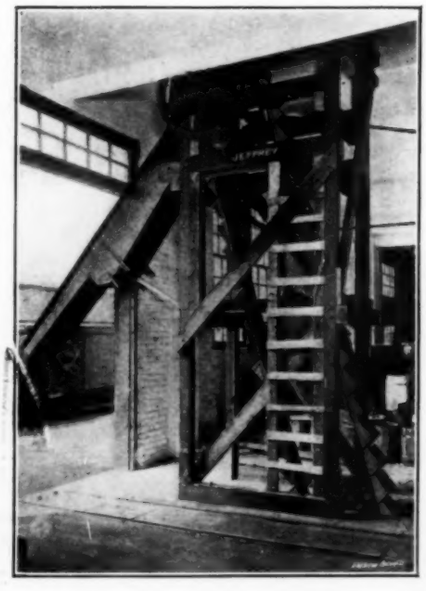
Figs. 4 and 5 show two different forms of shop stands. The first is designed to be used in connection with lathes and the lower shelf provides a convenient place for all change gears, as well as for the various sizes of dogs. Above this are two shelves and a convenient drawer for small tools or gages.

Fig. 5 is a portable shop stand, having shelves 14x48 inches, which can be conveniently moved to any part of the shop. A stand of this kind is frequently used to advantage for holding work after it is operated on by one machine, and the whole stand then moved to the next machine for further operations.

Conveyer for Nut Scrap

The illustration shows a conveyer installation for handling the scrap from nut-making machinery, in the works of the Columbus Bolt and Nut Works, Columbus, O.

The conveyer was built by the Jeffrey Manufacturing Company, Columbus, O., and handles the scrap from the basement to the car in a very economical manner. Each bucket has a capacity of from 40 to 50 pounds of scrap, as usually loaded.



CONVEYER FOR NUT SCRAP

The scrap is shoveled into a receiving hopper in the basement which loads the buckets automatically. The loading chute at the top is provided with perforated screens, and may be extended to reach the car. The dirt which goes through the screens is returned to the basement.

A Portable Electric Drill

The halftone shows a handy portable electric drill made by the New York Electric Tool Company, 136 Liberty street, New York. In this drill a specially designed well built, street-railway type motor has

A PORTABLE ELECTRIC DRILL

taken the place of the light fan-type motor sometimes found in this class of tool, and hardened-steel and phosphor-bronze gears have supplanted cast iron. The body is made of soft, tough steel, thoroughly annealed to offer the highest possible magnetic permeability for the motor fields, while at the same time it acts as an efficient protector for the vitals of the machine.

The ends are made of a special aluminum alloy, capable of withstanding without deflection a stress many times greater than any which can possibly be put on them in use. These ends take all the thrust. The gearing is so balanced that it imparts no side thrust to the chuck spindle or armature bearings. Ball bearings are used throughout. The hardened feed screw has a Whitworth thread which is less liable to be bruised than the U. S. S. thread. The machine will drill a ¼-inch hole in steel and a 3-inch hole in wood.

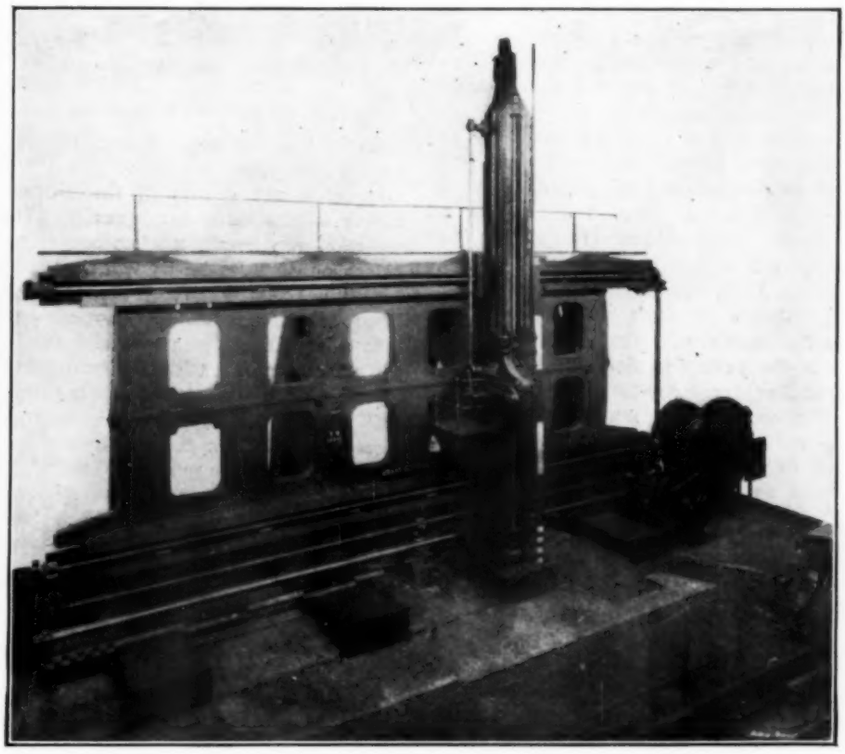
A Wall Planing Machine

The machine shown in the halftone is provided with electric drive and will plane 32 feet 6 inches long by 21 feet 4 inches high.

The machine consists of four heavy standards placed side by side, carrying two horizontal parallel beds, along which the vertical slide carrying the tool carriage is traversed by screw. The counterbalanced tool carriage has a traverse screw up and down the vertical slide, so that it is possible to plane both horizontally and vertically.

The automatic in and out traverse of the tool slide is two feet.

The drive of the machine is obtained through gearing from a variable-speed reversing electric motor of about 40



A WALL PLANING MACHINE

horsepower. The cutting speed is variable from 20 to 60 feet, whereas the return speed is constant at 60 feet per minute.

The horizontal motion is through bevel gears on the vertical shaft, to the right, which drive the horizontal screws.

The feed is controlled by a horizontal feed shaft which connects with the vertical feed screw. The vertical planing motion is also effected by the same gearing. The horizontal shaft transmits motion by means of bevel wheels to the feed screw in the vertical bed, while the feed is transmitted by the vertical shaft to the horizontal feed screws in a similar manner, as in the case with the horizontal planing motion.

The nuts of the screws are of phosphor bronze and split, so that they can be adjusted for taking up wear; the bearings of the high-speed shafts are also of phosphor bronze. The bevel gears and pinions, as well as the main driving shafts are of forged steel and all gears have machine-cut teeth. The machine weighs approximately 175,000 kilograms (367,500 pounds), and is built by Ernst Schiess, Werkzeugmaschinenfabrik A.-G., Düsseldorf, Germany.

Machine Feeds and Speeds

By Samuel L. Platt

Standardization of feeds and speeds for different classes of work a desirable feature.

Utility of charts to keep feeds and speeds standard, and advantage in buying new machines.

The work in a machine shop or any other manufacturing plant is one mass of details. Many managers claim they have no time for details nor have they, in the larger sense, but in spite of the assertion, they are dealing with them in groups, if not separately. Some of these details would not exist if machine-tool makers would standardize feeds and speeds.

One of the principal uses of cost and production records is for comparison with previous lots, the time of different men on the same operation as a basis for arriving at piece-work prices, in making estimates for new work. It sounds easy. As our manager put it, "all you have to do is to look over the time cards."

This remark is correct only as far as the time card relates to one particular make of machine. Take the same operation and the same man on another make of machine and you find he has developed speed since the last time he did that same job; or has contracted the habit of moderation, as the case may be. Nine times out of ten the man will get the credit or the blame and the matter stops there, as the discrepancy is not great enough to cause further investigation. But when a piece price has been adopted at a figure lower than day work, yet high enough to give the hustler an increase, discontent is very liable to crop out. Bill makes more than he did before. John, working steady and hard, falls below his day's wages.

He complains, perhaps only to be told that the price for piece work is settled and he goes. Another takes his place. After working long enough to master the kinks, he finds he cannot make as much as Bill does, though he works equally hard, and he hunts another job. So far it is all the fault of the men.

One day Bill's machine breaks down—he takes another one, the man having left because he "couldn't make enough." After a day or so Bill discovers he cannot get out the same quantity of work he did before and kicks.

Getting at the bottom of it brings out the fact that the last machine's feeds and speeds are not the same as the other make he had worked on; if increased to the next combination higher, it is too fast for the work. An adjustment of the piece price has to be made to equalize.

Before this was done two or three men had come and gone, from that one job, breaking up the organization—a serious matter.

When the piece-work price was changed, as it had to be to suit three or four different makes of the same style of machine, it wouldn't take a Philadelphia lawyer to figure the increased amount of work necessary in the paymaster's and the cost departments.

Making Estimates

Every machine-shop owner, manager or superintendent knows only too well that feeds and speeds of the different makes of machines vary greatly. This variation may be slight when one or two pieces only are to be worked, but when quantities are run through it becomes a more serious matter. As an example, take a large shop, with several makes of the same type of machine, where an estimate has to be made and a competitive bid submitted. The figures must be close, but how can they be unless it is possible to tell in advance just which one type of machine that order, if gotten, will go on? If the slowest machines are taken as a basis, it may be just enough to lose the order. To figure on the particular machines to do the work is almost impossible. They may be available at the time the estimate is made, but when the order finally reaches the shop other work has come in and those machines cannot be used to advantage.

Charts for Shop Use

Many shops are trying to standardize their own work and are issuing charts to guide the mechanic as to the proper speeds and feeds for the different classes of work, instead of relying on the man operating the machine and his judgment. As soon as this is started, the difference between the feeds and speeds of different machines becomes very apparent, necessitating a number of different charts when one should be enough. After the charts are gotten out, care must be taken to see that they are used on the right machine.

Buying New Tools

Considering the foregoing, it is not hard to see why some buyers who have gone through the experience of having different makes of the same machine in their shops, finally settle down on one make and refuse to consider any others. In selecting new tools, it saves a lot of trouble afterward if the feeds and speeds are the same as those already in the shop. The toolmakers would not suffer because their feeds and speeds were the same, as the special features that each claims for his particular line would not be affected. With automatic and turret machines it would be a great help to the management, production and cost departments if they all had the same feeds and speeds and it would save much trouble and bother.

Machine-tool makers, being large buyers and users of machine tools themselves, ought to appreciate the advantages and be as strong advocates of uniformity as other users.

Standardization is one of the things modern machine-shop practice is demanding on all sides—it is necessary to meet the present and future conditions.

Feed Lines

"Feed lines are caused by the 'lap' of the wheel cutting twice on that portion of the surface: viz., we do not traverse quite the exact width of the wheel at each revolution, but as near as safe and avoid ridges. The wheel cutting twice over this narrow place leaves a different grain, therefore a different color, even though the measurable diameter be no different than elsewhere."

Low Priced Cutting Compound

A large manufacturing firm which prefers to be unnamed favors us with the following cutting compound which is the result of many experiments and has proved itself both desirable and economical:

Secure a clean empty barrel, capacity about 50 gallons, and have it steamed and washed, free from any deposit of glue or any other residue. Into the empty barrel place 2½ pounds soda ash (caustic soda will not do), fill the barrel ¾ full of cold water. The dissolved soda ash will inoculate the water after slight agitation, then add 3 to 5 gallons mineral lard oil; this will cause the mineral lard oil to immediately emulsify, producing a white solution resembling milk. The balance of the barrel may be filled with cold water.

This mixture is chemically made, consequently proportions of soda ash should be weighed, not guessed at. Two and one-half pounds (2½) of soda ash to a barrel of 50 gallons of water does not produce over 1 per cent. alkali, and when oil is added there is no trace of alkali, and there is nothing to injure the hands. For exceedingly hard water double the amount of soda ash.

This mixture costs, when made, about 2½ to 3½c. per gallon, requiring no recharging to maintain its body. It does not foam, gum or produce a metallic soap, and positively will not rust any part of the machine or the work, making it a cutting compound at a low price that should prove attractive.

Increasing Shop Capacities

Metal Working

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

H. F. Perkins will open a machine shop at Malone, N. Y.

Hahn Garage Company, Bridgeton, N. J., is building a new garage.

The Cortland (N. Y.) Forging Company is erecting a large addition.

The Bromwell Wire Company, Greensburg, Ind., will erect an addition.

The Heer Engine Company, Portsmouth, Ohio, will erect a new plant.

The Goyne Steam Pump Works, Ashland, Penn., is building an addition.

The Regina (Sask.) Foundry Company will build additions to its plant.

The Steel Car Forge Company, Ellwood City, Penn., is erecting additions.

Harvey F. Kern, Allentown, Penn., is erecting a garage and wagon warehouse.

The Illinois Nail Company, Chicago, Ill., has purchased site for a new plant.

The Knickerbocker Typewriter Company will start a factory at Niantic, R. I.

The plant of the Don Foundry Company, Toronto, Ont., was destroyed by fire.

The Zanesville (Ohio) Machine Company will install some new machine tools.

The Lattimer Supply and Machine Company will erect a new plant at Hazleton, Penn.

The Erie (Penn.) Pump and Engine Company is building and equipping a new plant.

The Empire State Electric Vehicle Company will erect a new plant in Rochester, N. Y.

The Western Bridge and Equipment Company will build a new factory at Chatham, Ont.

The Halifax & Eastern Railway will establish large shops and terminals at Dartmouth, N. S.

Mack Brothers Motor Car Company, Allentown, Penn., is erecting an addition to its plant.

The Southwestern Iron Works Company, Guthrie, Okla., will erect an addition to its plant.

The plant of the Anderson (Ind.) Knife and Bar Company was destroyed by fire. Loss, $30,000.

The West Penn Steel Company, Tarentum, Penn., will make improvements to cost $30,000.

F. E. Myers & Bro., Ashland, Ohio, will erect a new foundry for making light gray-iron castings.

The Verity Plow Works, Brantford, Ont., will make extensions and improvements to cost $60,000.

The large repair shops of the C. P. R., at Brownville Junction, N. B., destroyed by fire, will be rebuilt.

The Canadian Pacific Railway will locate a new roundhouse and machine shops at Kamloops, B. C.

It is reported that P. J. Holm & Sons, of Chippewa Falls, Wis., will enalrge their gasolene-engine factory.

The Broughton Bolt Company, Cleveland, Ohio, will move to Elyria, Ohio, where a new plant is being erected.

The Ingersoll Milling Machine Company, Rockford, Ill., is said to be contemplating improvements at its plant.

The Grant-Wood Company, Detroit, Mich., is building a new shop at Chelsea, Mich., for its ball-grinding department.

The Chicago & Northwestern Railroad will spend $75,000 in erecting a roundhouse and machine shops at Fulton, Ill.

The Hannibal (Mo.) Tool Company, a new concern, is in the market for lathes, milling machines, drop hammers, etc.

The Mianus Motor Company, Stamford, Conn., manufacturing gasolene engines, will build an addition to its plant.

The Rayfield Motor Company, Springfield, Ill., has increased its capital stock and will make extensive improvements.

Fort Orange Garage, 70 Dove street, Albany, N. Y., expects to install a lathe and drill press within two months.

The Canadian Pacific Railway is building a large machine shop in connection with its roundhouse at Calgary, Alberta.

The Ansted Spring and Axle Company, Connersville, Ind., is erecting a new plant to replace the one recently burned.

The Portland (Ore.) Railway, Light and Power Company is erecting a new building to be used for repairing purposes.

The Davis Sewing Machine Company, Dayton, Ohio, is building an addition to accommodate its increasing bicycle business.

The Ajax Auto Traction Company has secured site at Kenton, Ore., and will erect a plant for the manufacture of gas engines.

The American Valve and Meter Company, Cincinnati, Ohio, has taken out a permit for the erection of a $45,000 factory building.

Henry Disston & Sons have awarded contract for the erection of a cold-rolling mill at its plant in Tacony, Philadelphia, Penn.

The Ringen Stove Company, St. Louis, Mo., is erecting a new plant to consist of ten structures which will cost over $500,000.

H. A. Bangs, 893 Boylston street, Boston, Mass., interested in a large automobile factory, is seeking site in the Central West.

H. A. Knease & Son, Iowa City, Iowa, will equip auto garage with complete machinery for repairs. Will need lathe, drills, etc.

Roundhouse and machine shops of the Chicago & Northwestern Railroad, at Chadron, Neb., were destroyed by fire. Loss, $40,000.

J. W. O'Donnell, 24 Abbott street, Salem, Mass., is in the market for a 16-inch engine lathe, 36-inch by 12-foot planer, wet grinder.

A new three-story automobile factory, to cost $50,000, is planned for Scharer & Woodworth, 280 Jefferson avenue, Detroit, Mich.

The Ford Motor Car Company, of Detroit, Mich., is ready for instalment of machinery in its new building erected at Kansas City, Mo.

The Illinois Watch Company, Springfield, Ill., is building an addition to its factory and there is talk of still further enlarging the plant.

The Scott Manufacturing Company, of Moline, Ill., will move to Des Moines. The company manufactures gas heaters for bath rooms.

Case Brothers, of Kane, Penn., are looking for suitable location in the New England section on which to locate a branch cutlery factory.

The Diamond Gas Company, Nashville, Tenn., with offices at 302 Church street, will establish a plant for the manufacture of gas machines.

The American Radiator Company is erecting a plant at Sheffield, Kansas City, Mo., which will soon be ready for instalment of machinery.

The Tarentum (Penn.) Manufacturing and Construction Company will erect a new plant for the manufacture of boilers and structural iron work.

The Reid Newfoundland Company will erect a large foundry and machine shop in connection with its drydock and works at St. Johns, Newfoundland.

The Gilbert Improved Corrugated Culvert Company, Aberdeen, S. D., will erect a two-story addition to be used for the manufacture of steel tanks.

Chas. J. Anderson, proprietor of the Menominee (Wis.) Iron Works, recently burned, is considering rebuilding same or will move to another locality.

The National-Acme Manufacturing Company, Cleveland, Ohio, building automatic screw machines, is erecting a four-story addition to its plant.

The Standard Rock Drill Company, Denver, Colo., capitalized at $60,000, will locate its plant at 1730 Wazee street, for the manufacture of rock drills.

The Canadian Fairbanks-Morse Company, of Toronto, will increase its machine shop 75 per cent., double foundry capacity and install a brass foundry.

The Union Drop Forge Company, Chicago, Ill., has awarded contract for the construction of a new plant, which includes machine shop, hammer shop, etc.

Work will soon be started on a new plant for the Vim Motor Company, at Sandusky, Ohio, contract having been awarded to Geo. W. Doerzbach & Brother.

Charles Miller, Hazleton, Penn., has leased the building of the Weatherly Foundry and Machine Company, which he will use for the manufacture of automobile trucks.

It is said the Louisville & Nashville Railroad contemplates building in South Nashville a plant for the manufacture of steel frames for freight and passenger cars.

The Gelier, Ward & Hasner Hardware Company, St. Louis, Mo., has increased its capital from $200,000 to $500,000. The increase will be used in enlarging the company's plant.

The Detroit (Mich.) Auto Specialty Company is putting up a two-story addition and contemplates further additions. The company manufactures gas engines, guards, fenders, etc.

The Union Pacific Railroad has let contracts for improvements to its shops at Omaha, Neb., to cost $500,000. These call for ten new buildings as an addition to the present shops.

The Commercial Club, of Tulsa, Okla., has closed a deal with the Robinson Boiler and Manufacturing Company, of Canton, Ohio, for a boiler, bridge and structural-steel factory to cost $150,000.

The Utah Light and Railway Company, Salt Lake City, Utah, has commenced the construction of two large shops, which are to be equipped with the latest machinery. These include machine shops and carpenter and paint shops.

The United States Engineering Company, composed of Pittsburg capitalists, has purchased site at Tarentum, Penn., and will erect a plant for the manufacture of engines, motors, electric supplies. Four hundred and fifty men will be employed.

The Anniston (Ala.) Chamber of Commerce has made arrangements for the location of the Pan-American Manufacturing Company, which will manufacture stoves. The building vacated by the Anniston Foundry and Machine Works has been secured.

J. M. Brady, 847 Main street, Hartford, Conn., is organizing a company to be known as the Rex Motor Company for the purpose of manufacturing a gasolene engine invented by Prof. J. J. Hogan, of Yale University, and which is designed chiefly for use in automobiles and aëroplanes.

With the incorporation of the Marion (Ohio) Shovel and Dredge Company, having an authorized capital of $400,000, plans have been begun for the erection of a mammoth steam-shovel plant on a site of 120 acres at the southwestern edge of the city. The new company will employ 2000 men.

General Manufacturing

Winnipeg, Man., will build a municipal gas plant.

The Manoose Bay (B. C.) Brick Company will erect a plant.

The Litchfield (Ill.) Lamp Company will build a new factory.

The Paducah (Ky.) Ice Company is interested in evaporators.

Vernon, B. C., will spend $10,000 for new waterworks equipment.

The Esmond (R. I.) Mills will install a lot of new machinery.

Chilliwack, B. C., will spend $15,000 for road-making machinery.

The mill of Black & Brown, woodturners, Boston, Mass., was burned.

Tillsonburg, Ont., will erect a $25,000 hydroelectric power plant.

Orangeville, Ont., will spend $20,000 for new waterworks machinery.

The Crookton (Minn.) Gas Works has secured site for a new plant.

John A. Mitchner, of Stratford, Ont., will erect a large furniture factory.

Tobin Brothers are erecting a mill for grinding feed at Victor, N. Y.

The Canadian Salt Company will locate a $35,000 plant at Sandwich, Ont.

The H. B. Smith Company, Westfield, Mass., will install an electric elevator.

The Canada Cement Company will equip a large plant at Winnipeg, Manitoba.

A municipal electric-light plant is to be installed by the city of Durant, Okla.

The Attawaugan Company, of Danielson, Conn., will install a new power plant.

The Wapakoneta (Ohio) Wheel Company, recently organized, will build a plant.

The construction of a waterworks system has been authorized at Bradley, S. D.

The Chaparra Sugar Company, Chaparra, Cuba, is interested in sugar machinery.

The Canadian Government will buy 80,000 tons of steel for the new Quebec bridge.

The city of Pella, Iowa, has sold $60,000 bonds and will install waterworks system.

Fire destroyed the power plant of the Buckeye Pipe Line Company, Otsego, Ohio.

The Peoples Pure Ice Company, Galion, Ohio, is interested in a 20-ton ice machine.

The Western Salt Company, Ltd., Mooretown, Ont., want triple-effect vacuum pans.

The Ahnapee Veneer and Seating Company, Algoma, Wis., will erect a two-story addition.

The Eastman Kodak Company, Rochester, N. Y., is building a large addition to its plant.

The Republic Rubber Company, Youngstown, Ohio, will erect a five-story addition.

The Gres Falls Company will locate large pulp and paper mills at Three Rivers, Que.

P. J. Cullen has leased a factory and will start a worsted mill at Stafford Springs, Conn.

The citizens of Delavan, Wis., will vote on issuing $16,000 bonds for waterworks system.

L. B. Dow, 176 Federal street, Boston, Mass., is in the market for a 30-inch burr mill.

Samuel Fox's Sons, La Porte, Ind., woolen manufacturers, will build a one-story addition.

H. R. Mosnat, of Belle Plain, Iowa, is said to have petitioned for a franchise for a gas plant.

The National Sulphur Works, Bayonne, N. J., recently destroyed by fire, will be rebuilt.

The D. Hibner Furniture Company, Listowel, Ont., is making large extensions to its plant.

The Merchants Ice and Cold Storage Company, Los Angeles, Cal., will enlarge its plant.

Parke, Davis & Co., Detroit, Mich., want prices, etc., on centrifugal pump for hot water.

The Osborn Manufacturing Company, New Durham, N. H., are taking prices on water wheels.

The plant of the American Bentwood Chair Company, at Otego, N. Y., was burned. Loss, $50,000.

It is reported that the Fisk Rubber Company, of Springfield, Mass., will erect an addition.

The Red Lodge Brewing Company, Red Lodge, Mont., will build a bottling house and brewery.

The plant of the Anderson Porcelain Company, East Liverpool, Ohio, was burned. Loss, $50,000.

The plant of the Corn Belt Packing Company, Fort Dodge, Iowa, was burned. Loss, $75,000.

The plant of the Zanesville (Ohio) Art Pottery Company was destroyed by fire. Loss, $100,000.

The plant of the Bay State Mill Company, Boston, Mass., was destroyed by fire. Loss, $100,000.

Fire destroyed the plant of the Damascus Brake Beam Company, at Sharon, Penn. Loss, $125,000.

A new pen factory is being erected for Walker & Davison on Draper avenue, Mansfield, Mass.

The city of Rutherfordton, N. C., has voted to issue $35,000 bonds for waterworks and light plant.

The Roland M. Baker Company, tanners, Salem, Mass., is seeking a suitable location for a plant.

The city council, McPherson, Kan., is preparing to erect a new light plant to cost about $20,000.

It is reported that bids will soon be called for the construction of waterworks system at Townsend, Mont.

The Anderson Textile Manufacturing Company, New Bedford, Mass., has purchased site for a new plant.

Permit has been taken out for a hosiery mill for the Consolidated Knitting Mill Company, Reading, Penn.

The Seagrave Company, Columbus, Ohio, manufacturing hook and ladder trucks, will erect a new factory.

The people of New Holstein, Wis., will vote on issuing $8000 bonds for equipping a municipal lighting plant.

The Union L. H. & P. Company, Fargo, N. D., will build an addition and install new engine and generator.

William Mullen, of Carter, S. D., is considering the installation of an electric-light system at Winner, S. D.

W. H. Judd & Co., Hamilton, Ont., are in the market for a small plant for concentrating soap lye for glycerin.

Baetz Brothers' furniture factory, recently destroyed by fire at Berlin, Ont., will be rebuilt and greatly enlarged.

Leas & McVitty, Inc., Philadelphia, Penn., are in the market for evaporator to evaporate extract from chestnut wood.

It is proposed to change the Lakefield (Minn.) electric plant to a modern one and install a gas-producer engine.

The Superior Manufacturing Company, Minneapolis, Minn., want a salt evaporator for Marine City, Mich., plant.

The George Close Company, Cambridge, Mass., will erect a new factory and will require refrigerating apparatus.

Proceeds of bond issue recently voted at New Philadelphia, Ohio, will be used for municipal waterworks system.

The North Dakota Heat and Power Company, of Fargo, N. D., will install a power and electric plant at Energy.

George Ellison, Stevens street, Haverhill, Mass., is in the market for a 10- to 15-horsepower gas or gasolene engine.

Genevieve & Driswold, of Rye, N. Y., have the contract for building a large lighting plant at South Norwalk, Conn.

The Columbia River Lumber Company's mills, at Golden, B. C., were destroyed by fire. Loss, $30,000. Will be rebuilt.

The C. B. Henschel Manufacturing Company, Milwaukee, Wis., making cigar boxes, will build a new $28,000 factory.

A. M. Byers Company, Pittsburg, Penn., has taken out a permit for the erection of a new pipe mill to cost about $225,000.

The Iowa City (Iowa) Water Works will install new engines and pumps, increasing its capacity to 8,000,000 gallons.

The Electric Service Supplies Company, Philadelphia, Penn., is proceeding with the construction of a new six-story factory.

The city of Shelbyville, Ill., has granted a franchise for an artificial-gas plant on which work will soon be commenced.

The Union Street mill of the Miner Hillard Milling Company, Wilkes-Barre, Penn., has been destroyed by fire. Loss, $20,000.

The Keystone Rubber Manufacturing Company, Erie, Penn., is building an addition in which a power plant will be installed.

Contract will soon be let for the proposed water and light plant at Milford, Neb. Martz Bros., of Seward, Neb., are the engineers.

The Ford Plate Glass Company, Rossford, Ohio, will make extensive improvements. A 3000-horsepower engine will be installed.

It is the intention of the city of Port Arthur, Ont., to increase its pumping capacity by a motor-driven centrifugal pump.

The Colorado (Tex.) Salt Company want quotations on double-effect vacuum pans to produce 520 barrels of salt per day of 24 hours.

The Wildermuth Bending Company, Columbus, Miss., will erect a $50,000 plant for the manufacture of hubs and spokes for automobiles.

Plans are being prepared for a $10,000 warehouse and garage for the Parmelee Transfer Company, at Adams and Halsted streets, Chicago, Ill.

Contract has been awarded for the erection of an addition to the machine shop of Hugo Bilgram, 1217-33 Spring Garden street, Philadelphia, Penn.

The chemical and varnish building, at the plant of Chas. J. Mathews & Co., manufacturers of glazed kid, Langhorne, Penn., was destroyed by fire.

The Temple-Stuart Chair Company, East Princeton, Mass., whose factory was destroyed by fire, is considering removal of its plant to another locality.

The Canadian Hair Company has sold its factory at Merrilton, Ont., to a syndicate which will operate it as a rubber factory, employing 300 men.

The Manchester (Iowa) Light, Heat and Power Company will enlarge its plant. Will install a 150-horsepower boiler and two 15-kilowatt transformers.

The National Light and Battery Company, Niagara Falls, N. Y., which has increased its capital to $500,000, has prepared plans for additions to its plant.

Giron Brothers, of St. Etienne, France, have purchased site at Taftville, Conn., on which a mill for the manufacture of silk-velvet ribbons will be erected.

The Electric Boat Company has leased the plant formerly occupied by the Eastern Shipbuilding Company, at New London, Conn., and will start a ship yard.

The Consumers Power Company, Stillwater, Minn., has secured control of the St. Paul Electric H. & P. Company, and will make extensive improvements.

The Ellsworth (Kan.) Salt Company want prices on vacuum-pan process capable of 500 barrels of salt per day, also outfit for 1000 barrels per day of 24 hours.

The E. C. Fisher Corporation, 27 Marion street, West Lynn, Mass., contemplates installing a new 150-horsepower engine. Will probably add also a generator.

The plant of the E. H. Barnes Company, Norfolk, Va., was destroyed by fire. Loss, about $150,000. The company manufactures boxes, barrel heads and staves.

The Akron-Selle Company, Akron, Ohio, will engage in the manufacture of automobile bodies and is looking for a suitable location for the manufacture of these.

F. W. Cappelon, of Minneapolis, Minn., will prepare plans for improvements to the waterworks system at Morning Side, Sioux City, Iowa, to cost about $30,000.

The Mercer County Brewing Company has let contract for the erection of a brewery at South Sharon, Penn., to cost $145,000. An artificial-ice plant will also be erected.

The John A. Stewart Electric Company, of Cincinnati, Ohio, has purchased the plant of the Nelsonville (Ohio) Electric Company. Extensive improvements are contemplated.

A 250-horsepower Corliss engine, 200-kilowatt generator, two 15-kilowatt exciters and a 50-horsepower motor will be purchased for the electric-light plant at Miles City, Mont.

Proposals will be received at the office of depot quartermaster, Army building, New York, until 12 o'clock noon, August 25, for two locomotives. Information on applicatin.

Fire destroyed head tipple power house, boiler house, carpenter shop and all equipment at shaft No. 9 of the Pennsylvania Coal and Coke Company, at Cresson, Penn. Loss, $100,000.

The H. F. Brammer Manufacturing Company, Davenport, Iowa, has let contract for the construction of a new plant. The company manufactures woodenware and washing machines.

The Warwick Valley Light and Power Company, Newburgh, N. Y., has asked the Public Service Commission for permission to execute a mortgage for $25,000, part of which will be spent on extensions and improvements.

The E. I. du Pont de Nemours Powder Company, of Wilmington, Del., has purchased the artificial-leather plant of the Newburgh (N. Y.) Fabrikoid Company and will enlarge it.

The Dixon Saw Palmetto Medicine Company, 215 Newman street, Jacksonville, Fla., want prices on copper vacuum pan with steam jacket, also copper separator and copper condenser.

The power plant of the Janesville Electric Company, at Fulton, Wis., slid 15 feet into the river recently, as a result of water from the river working under the foundations. The plant will be immediately rebuilt.

The Norwood (Ohio) Ice Company, capitalized at $35,000, which will be increased later to $75,000, is preparing to erect a plant. H. C. Wood, president of the H. C. Wood Ice Company, of Hyde Park, Ohio, is one of the incorporators.

Proposals will be received until 11:30 a.m., September 10, for one triplex motor-driven pump and two motors, one alternating current and one direct current, by Major G. D. Deshon, medical corps, quartermaster, Hot Springs, Ark.

Engineers J. C. Buckbee & Co., 164 Dearborn street, Chicago, Ill., are preparing plans for a plant for the United States Cut Stone Company. Will require traveling cranes, conveying machinery and a number of small motors.

The Worcester (Mass.) Consolidated Street Railway Company has plans completed for improvements at the Millbury power station. About $500,000 will be expended. New transformer station will be erected in which $100,000 worth of electrical apparatus will be installed.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., August 30, for switch stands, switches, steel rail, track torpedoes, bronze, toe calks, bolts, chaplets, pipe and fittings, valves, ball cocks, grease cups, water gages, twist drills, stocks and dies, etc., as per Circular No. 600.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids August 23, for six sets propelling machinery (schedule 2787), 3000 feet seamless brass pipe (schedule 2802), 3850 pounds rolled naval brass (schedule 2802), 500 pounds soft sheet brass (schedule 2799); August 30—Steam locomotive crane (schedule 2791), 11 sets, 5-kilowatt turbo generators and accessories (schedule 2792); September 6—Paint-mixing machinery (schedule 2793).

NEW INCORPORATIONS

Pope Motor Company, Jersey City, N. J. Manufacture automobiles. Capital, $125,000. Incorporators, Frank Koch, W. C. Fisk, C. E. Fisk.

Non-Capsizable Aero Plane Company, Paterson, N. J. Build aëroplanes. Capital, $50,000. Incorporators, W. P. Grey, Jos. Van Walraven, P. L. Alberse.

Boyden Shoe Manufacturing Company, Newark, N. J. Manufacture shoes. Capital, $150,000. Incorporators, T. Frank Metcalfe, Edmund Marsh, C. Hauck.

Lake Shore Brick Company, Painsville, Ohio. Manufacture brick, etc. Capital, $10,000. Incorporators, Guy Wyman, H. E. Hammar, P. Prentice, etc.

The Vaco Company, Bloomington, Ill. Manufacture and sale of vacuum cleaners, etc. Capital, $50,000. Incorporators, C. F. J. Agle, E. B. Hack, F. W. Russell.

Chicago Perforating Company, Chicago, Ill. Manufacture machinery and metal work. Capital, $35,000. Incorporators, H. C. Finlay, G. W. Moore, Michael Koch.

Horman Manufacturing Company, Brooklyn, N. Y. Manufacture ventilators, etc. Capital, $25,000. Incorporators, J. E. Horman, W. H. Barr, W. E. Tunison.

Star Garage and Taxicab Company, Sandusky, Ohio. Operate garage. Capital, $25,000. Incorporators, F. J. Herman, J. E. Herman, W. B. Friesinger, etc.

Automatic Sales Company, Chicago, Ill. Manufacture vending machines. Capital, $30,000. Incorporators, Roy E. Knauer, John L. Gaffney, Louis P. Larson, Jr.

New Jersey Overland Company, Newark, N. J. Manufacture automobiles. Capital, $100,000. Incorporators, W. F. Acker, H. Heinsheimer, R. D. Crocker, etc.

Madison Auto Company, Jersey City, N. J. Manufacture automobiles, motor trucks, etc. Capital, $25,000. Incorporators, W. W. Stewart, W. S. Rowland, C. W. Grant.

Sanford Herbert Company, Syracuse, N. Y. Manufacture and deal in motors, engines and machinery. Capital, $25,000. Incorporators, C. G. Herbert, F. F. Sanford, etc.

Roebuck Manufacturing Company, New York. Manufacture and deal in wire screens, etc. Capital, $25,000. Incorporators, W. P. Niebringge, H. S. Park, B. L. Maxfield.

Standard Leather Manufacturing Company, Jersey City, N. J. Manufacture leather goods. Capital, $500,000. Incorporators, R. T. Colborn, Wm. T. Huguley, Carl H. Fowler.

Eureka Smoke-Consumer Company, Rochester, N. Y. Manufacture and sell smoke consumers. Capital, $50,000. Incorporators, J. R. Armstrong, F. Fish, G. Simmons.

F. N. Wakefield Brass Company, Vermillion, Ohio. Manufacture lighting fixtures, etc. Capital, $10,000. Incorporators, F. W. Wakefield, A. C. Hofrichter, E. H. Wakefield.

American Vending Machine Company, Plainfield, N. J. Manufacture slot machines. Capital, $300,000. Incorporators, Frank L. C. Martin, Ernest Sharpe, Peter A. Elliott.

Edwin F. Alf Company, Cincinnati, Ohio. Manufacture carriage and automobile trimmings. Capital, $25,000. Incorporators, Edwin F. Alf, Harry C. Jay, B. Lamping, etc.

Malgam Brush Company, Newark, N. J. Manufacture brushes. Capital, $200,000. Incorporators, C. W. Fairlie, Newark; J. H. Bowne, East Orange; J. A. Bowne, Orange.

The Monitor Time Clock Company, Syracuse, N. Y. Manufacture and deal in time clocks, etc. Capital, $25,000. Incorporators, F. H. Johnson, W. D. Hawley, C. L. Forbes.

Case Motor Car Company, New Bremen, Ohio. General automobile and garage business. Capital, $50,000. Incorporators, J. H. Grothaus, E. Grothaus, J. F. Landferseik, etc.

New York Equipment Company, Trenton, N. J. Manufacture mechanical and engineering supplies. Capital, $125,000. Incorporators, E. H. Bensel, A. J. Trier, Wm. J. Walsh.

Dayton Commercial Auto Truck Company, Dayton, Ohio. Manufacture and repair automobiles, etc. Capital, $50,000. Incorporators, L. L. Wehner, H. A. Lewis, Geo. W. Ozias, etc.

Harwood Lumber Company, Cleveland, Ohio. General lumber business and manufacture woodwork. Capital, $15,000. Incorporators, John J. Harwood, R. H. Harwood, Frank H. Ewing, etc.

Clyde Cooperage Company, Clyde, Ohio. Manufacture and sell cooperage and other wooden products. Capital, $100,000. Incorporators, J. W. Worst, Julius Walde, George Siussman, etc.

Dr. Stearns Invalid Auto Company, New York. Manufacture vehicles and conveyances for invalids, automobiles, etc. Capital, $50,000. Incorporators, H. H. Stearns, M. T. Shier, C. H. Sanborn.

Safety Foot Guard and Railway Appliance Company, Columbus, Ohio. Manufacture railroad safety foot guards, etc. Capital, $10,000. Incorporators, G. D. Ridenour, S. P. Booth, H. J. Schwartz, etc.

Lindell Motor and Auto Parts Manufacturing Company, St. Louis, Mo. Manufacture and deal in motor vehicles, accessories, etc. Capital, $6000. Incorporators, E. B. Campbell, A. A. Wagner, Geo. S. Branks.

International Automobile League Tire and Rubber Company, Buffalo, N. Y. Manufacture tires, motor vehicles, automobiles and sundries. Capital, $1,000,000. Incorporators, Alfred C. Bidwell, Wm. Preiss, Chas. H. Bowe.

James S. Johnston Manufacturing Company, Utica, N. Y. Manufacture machinery, electrical supplies and appliances. Capital, $100,000. Incorporators, C. A. Powell, Whitesboro; J. S. Johnston, L. A. Johnston, Utica.

Electro-Chemical Rubber and Manufacturing Company, Jersey City, N. J. Manufacture electric motors, dynamos, etc. Capital, $200,000. Incorporators, L. Daft, Rutherford, N. J.; A. H. Martin, Short Hills; C. E. Haydock, W. M. Clark, New York.

Business Items

Garwood Electric Company reports having taken a number of orders recently, among others one for two 100-kilowatt and one 75-kilowatt engine-type generators and a number of slow-speed motors for ventilating work.

Ph. Bonvillain & E. Ronceray, of Paris, France, who exhibited French molding machines in this country, have purchased back from the E. H. Mumford Company the United States patent rights for the universal molding machines and pattern system of their origin.

Trade Catalogs

Roth Brothers & Co., Chicago, Ill. Bulletin No. 193. Type T motors. Illustrated, 12 pages, 6x9 inches.

W. W. Oliver Manufacturing Company, Buffalo, N. Y. Bulletin No. 10. Crown dental rolling mill. Illustrated.

E. M. Dart Manufacturing Company, Providence, R. I. Pamphlet. Unions, flanges, elbows and fittings. Illustrated.

The Miami Valley Machine Tool Company, Dayton, Ohio. Circular. No. 1 universal tool and cutter grinder. Illustrated.

The Brown Instrument Company, Philadelphia, Penn. Catalog No. 3. Electric pyrometers. Illustrated, 46 pages, 7½x10½ inches, paper.

Diamond Saw and Stamping Works, Buffalo, N. Y. Catalog. Sterling hack-saw blades and frames, power machines, etc. Illustrated, 16 pages, 4x7 inches.

The Cutler-Hammer Manufacturing Company, One Hundred and Forty-fourth street and Southern Boulevard, New York. Catalog. Battery-charging rheostats. Illustrated, 48 pages, 5x8 inches.

Forthcoming Meetings

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.
regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

New ideas developed, designing and detailing of special machinery; terms reasonable and work strictly confidential. Box 798, AMERICAN MACHINIST.

A well equipped machine shop within 30 miles from New York solicits orders for all kinds of machine work. Send inquiries: The Brunswick Refrigerating Co., New Brunswick, N. J.

Light or medium weight machinery to manufacture on contract or special machinery to build. Box 734, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Any broken machinery parts expertly welded by oxy-acetylene process; difficult repairs

requiring skilful preheating are our specialty; automobile cylinders and crank cases also; ask for detailed information, references, etc.; we positively weld (not braze) cast iron, aluminum and other metals; no charge unless successful; one trial will convince you. Waterbury Welding Works, Waterbury, Conn.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Wanted — Bookkeeper for manufacturing plant, employing from 20 to 25 hands; young man familiar with modern uptodate methods, cost keeping, etc. Write fully age, experience, salary wanted. Box 812, AMER. MACHINIST

CANADA

Wanted — First-class man on automatic screw machine work, setting up, camming, devising new tools and methods speeding up; highest wages to the right man. Box 825, AMERICAN MACHINIST.

COLORADO

Due to the steady increase of our business, we are constantly in need of drill press, lathe, planer, grinder, Jones & Lamson and bench men; also toolmakers and tool smiths; good climate and location; steady work, good pay to first-class men; shop clean, light and well ventilated; 9 hours work. Address, stating experience. J. Geo. Leyner Engineering Works Co., Littleton, Colo.

CONNECTICUT

Wanted—First-class draftsman. Apply by letter to Waterbury Clock Co., Waterbury, Conn.

Wanted—We want a machine salesman to cover territory in and around New York City; standard machine that is used in all factories. Address P. O. Box 685, Waterbury, Conn.

Wanted—Salesmen to handle on a generous commission basis, a well advertised and quick selling line of lathe tools; commissions given on all orders received from prescribed territory; send references with reply. Address "R. T.," AMERICAN MACHINIST.

INDIANA

Wanted—A-1 man for tempering tools; one who has experience in case-hardening preferred; give experience and references. Address "A. B. C.," Box 186, Indianapolis, Ind.

Wanted—A thoroughly capable foreman for tool room employing twenty toolmakers and machinists; must be naturally endowed with capacity to command respect of workmen and be thoroughly experienced in very accurate and exacting punch and die work. Address "A. B. C.," Box 186, Indianapolis, Indiana.

MASSACHUSETTS

Wanted—Experienced and designing draftsmen. Address replies to Supervisor of Drafting Rooms, General Electric Co., Pittsfield, Mass.

NEW JERSEY

Lathe and vise hands in shop, 15 miles from New York; must be sober and steady; opportunity for advancement; state experience, references, wages and all information in first letter. Box 843, AMER. MACHINIST.

NEW YORK

Wanted—First-class machine tool salesman, one with practical experience preferred. Box 840, AMERICAN MACHINIST.

Wanted—First-class men for steady work on milling and grinding machines. E. W. Bliss Company, Adams & Plymouth Streets, Brooklyn.

Wanted—First-class lathe hands, planer hands, boring mill and slotter hands; also a few erectors; must be first class and accustomed to heavy work. Address P. O. Box 953, Buffalo, N. Y.

Wanted—Experienced draftsman with experience in furnaces, structural steel, piping, etc.; small town in western New York; give full particulars and state salary required. Box 826, AMERICAN MACHINIST.

Wanted—First class lathe and grinder hands; steady work, good wages; nine hours per day; no labor troubles. Apply in person or write the P. H. Gill & Sons Forge & Machine Works, 2 Lorraine St., Brooklyn, N. Y.

Automatic screw machine operator; an experienced man on Brown & Sharpe, Cleveland and Spencer automatic machines, to act as assistant to foreman over about fifty men. Address, stating age and experience, Box 853, AMERICAN MACHINIST.

OHIO

Machinists wanted on locomotive work in the Middle West. Box 770, AM. MACH.

Machinist wanted to instruct men in the use of machine tools; give age, experience. Box 771, AMERICAN MACHINIST.

Wanted—General machine shop foreman, capable of managing the machine department of an electrical plant, manufacturing small motors and dynamos; applicant must be A-1 in handling men and equipment; state age, experience and salary. Box 845, AM. MACH.

Wanted—Superintendent in Cincinnati, experienced in building lathes and radial drills; applicant must show good past record and must be capable of assuming entire charge of the manufacturing end of our business. Box 862, AMERICAN MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Floor hands and fitters on machine tool work. Colburn Machine Tool Co., Franklin, Penn.

Machinists—Machine operators wanted for day and night turn; plenty of work; none but sober and steady men need apply. Standard Engineering Co., Ellwood City, Penn.

Tool draftsman and designer with shop experience, desires to change; Philadelphia or vicinity. Box 839, AMERICAN MACHINIST.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

RHODE ISLAND

Wanted—Salesman on hoisting engines; must be acquainted with the trade; opportunity of a life time for the right man; applications will be received until September 1 Box 850, AMERICAN MACHINIST.

Wanted—Superintendent for shop on medium heavy engine work; splendid opportunity for the right man; must be uptodate and able to modernize in the best sense of the word; no system crank need apply; applications received until September 1. Box 849, AM. MA.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Situation as superintendent in some steam specialty factory; lubrication or oiling devices preferred. Box 858, AMER. MACHINIST.

MASSACHUSETTS

Special machine designer wishes to change. Box 864, AMERICAN MACHINIST.

Wanted—Position as foreman of screw machine department; expert on estimating speeds and feed, and best method of production. Box 863, AMERICAN MACHINIST.

Superintendent of a large manufacturing plant, with wide experience on automatic and labor saving devices, desires making a change. Box 788, AMERICAN MACHINIST.

MISSOURI

Position as general foreman; now employed; 15 years' experience on small and medium interchangeable parts; thoroughly up to date on dies, jigs and manufacturing facilities; A-1 hustler and good executive ability. Box 852, AMERICAN MACHINIST.

NEW JERSEY

Master mechanic, energetic, progressive and up to date, practical toolmaker and designer, experienced on accurate and interchangeable work; now employed but wishes change; best references as to ability and integrity. Box 835, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer, 10 years' experience, open for engagement. Box 855, AMER. MACH.

Machine blacksmith wants steady work; fully able to take charge of shop. Box 851, AMERICAN MACHINIST.

Draftsman, well experienced detailer, good mechanic, wishes responsible position. Box 854, AMERICAN MACHINIST.

Mechanical engineer, 18 years' experience in tool and dies, and well familiar in die castings. Box 856, AMERICAN MACHINIST.

Mechanical draftsman, aged 20, desires position; two years' experience; low salary considered; reference furnished. Box 859, AM. M.

Foreman, middle aged, now employed, latest methods, engineering, dynamos, electrical and general machinery; A-1 hustler; can handle force with executive ability. Box 860, AM. M.

Superintendent and factory manager, has specialized in organization, equipment, methods of production and paying for labor and cost accounting; established reputation as a capable executive. Box 846, AMER. MACH.

Expert mechanic, technically educated, with ten years' practical experience in toolmaking and experimental work, desires change; expectations moderate; age 30, married; West or Middle West preferred. Box 857, AM. MA.

PENNSYLVANIA

Mechanical engineer; extensive shop practice; expert on cost reduction and increase of output; uptodate in modern shop methods. Box 831, AMERICAN MACHINIST.

RHODE ISLAND

Salesman having wide acquaintance with manufacturing interests in New England, desires to represent progressive concern manufacturing high-grade product; salary or commission basis. Box 861, AMER. MACHINIST.

FOR SALE

For Sale—Nearly new No. 16 oven furnace. Mr. Wales, Keene, N. H.

For Sale—One Rarefied dust collector, new; never been used; will make price right. The Ready Tool Co., Bridgeport, Conn.

Four thousand dollars will buy a light manufacturing machine shop, brass foundry and plating works, doing a safe, steady, profitable business in this city; established twenty years; health only reason for selling. For full information address Hoyt Investment Company, 4290 Queen Ave., South, Minneapolis, Minn.

For Sale—Three return tubular boilers, manufactured by Riter Bros., Buffalo, N. Y. Drums 72x16 feet 0 inches; each boiler with sixty-six 4-inch tubes; inspected by Travelers Indemnity Company, of Hartford, Conn; 93 lb. steam pressure; boilers in good condition; can be delivered in two to three months, and seen in operation at Buffalo Bolt Company's plant, North Tonawanda, N. Y.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

For Sale—One Nash gas engine, 20 horsepower, two cylinder, for electric lighting, pumping or power; one Beaman & Smith horizontal boring mill; table 25 inches wide, 36 inches long; will bore 12 inches diameter, 24 inches long, and face 20 inches diameter; one 300 light J. B. Colt Co. acetylene gas apparatus. The above machines are in excellent condition, having been very little used. For further particulars and prices apply to Rider-Ericsson Engine Co., 35 Warren St., New York.

For Sale—Machine shop, foundry, boiler, blacksmith and pattern shop and general machinery supply business; complete equipment and doing a profitable business; located in the greatest coal, metal mining and smelting, timber and farming section of Colorado; fine city, climate, water and schools; unusual opportunity for machinist and foundryman to form partnership and secure prosperous growing business, at a sacrifice; family death necessitates owner leaving. Box 800, AM. M.

Talks With Our Readers

By the Sales Manager

HERE'S a letter we received some time ago:

THE AMERICAN MACHINIST,
New York, N. Y.

Gentlemen:

I wish to make a suggestion which I think would be of much interest and greater benefit to your readers, as well as to your enterprising advertisers.

It takes quite a while to look over all the advertising each week, and yet every progressive manufacturer feels that he must keep in touch with every new apparatus and device. Is it not possible for you to print an index in each issue, indicating the names of the advertisers who are new or who have changed their copy, together with the numbers of the pages on which such advertisements appear?

Yours very truly,
THE STERLING MFG. CO.,
WARREN D. CHASE,
General Manager

Thirteen years ago there was need for such an index—there is none now.

Then practically every advertisement that appeared in any technical paper was a standing card—it gave no information except the name and address of the concern and product made.

It was a landmark that only new comers took any particular notice of, or "a card that served to keep the maker's name before the public."

It's different now.

* * *

The Bullard Machine Tool Co. was the first advertiser in the AMERICAN MACHINIST to regularly change its copy. It came about in this way:

In 1897 the Old Man, while talking with Mr. Bullard, told him that he had no more right to expect the readers of the AMERICAN MACHINIST to read the same advertisements week after week, than did the editors the same editorials week after week.

That an advertisement that didn't give information, just the kind of selling information that a salesman would give in a personal interview, was shirking—wasn't doing half what it should.

Mr. Bullard said he didn't have time to attend to it.

The Old Man offered to show what could be done.

He was glad of the opportunity to show what a great educational force, what a power, advertising was for creating business. He did.

* * *

That was the beginning of our Service Department.

Last year this department cost us over $13,000. This year it is costing much more.

It does nothing but make the advertisements in our papers more interesting, informative and accurate.

That's one reason why the advertising pages of the AMERICAN MACHINIST are just as important from the *reader's* standpoint as are the editorial pages.

Why, every time we skip the advertising pages we are missing something, overlooking helpful suggestions, practical ideas that will get better results for us at a saving of labor, or money, or time.

* * *

Say you saw it in the American Machinist.

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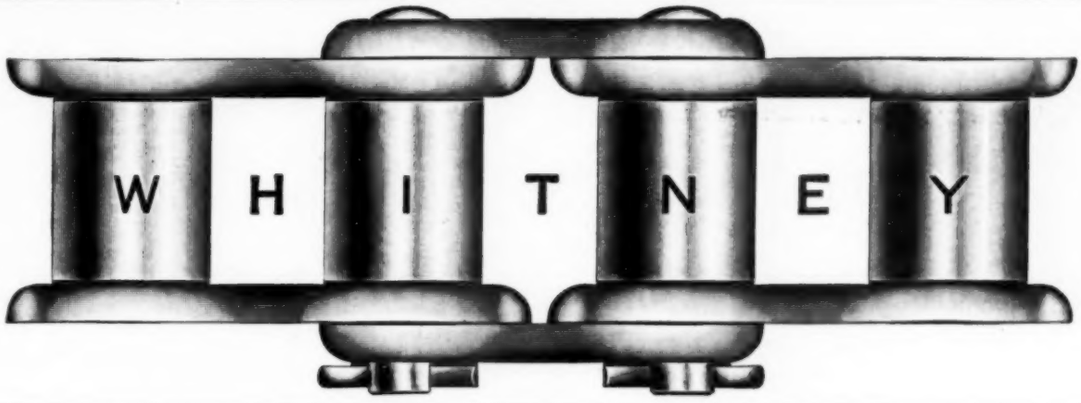
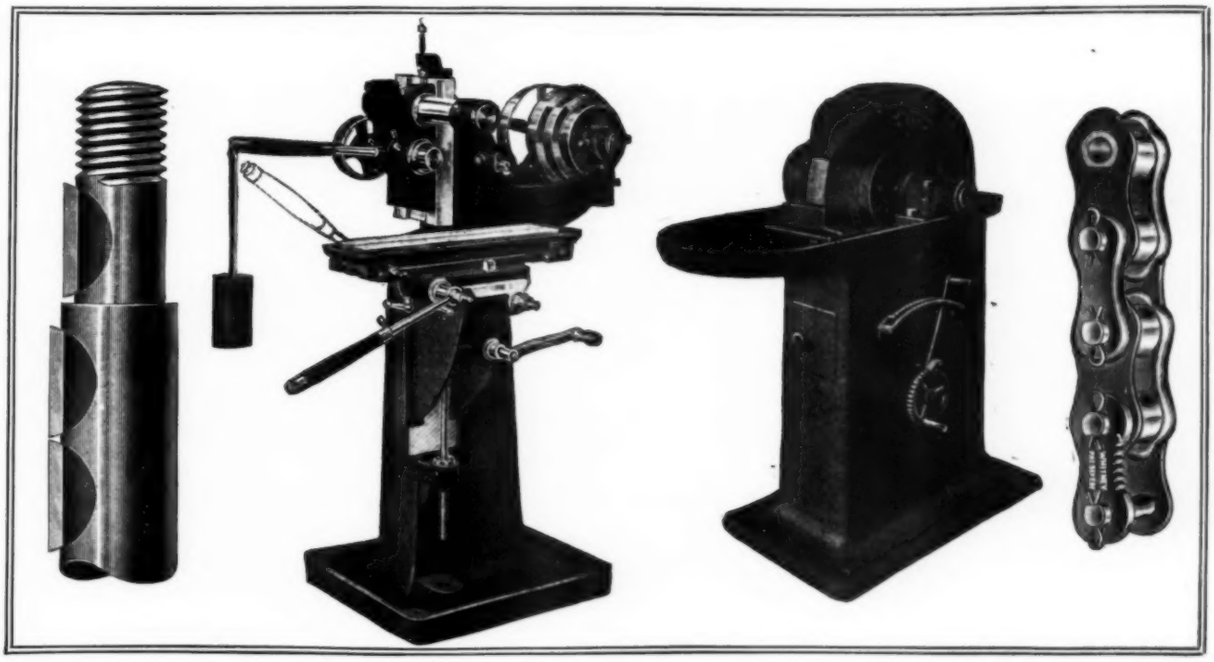


Chain Department

Roller Chains, Block Chains, Chain Belts, Quiet Chains, for Automobiles, Commercial Cars, Motorcycles, Bicycles, Machinery, etc.

Machine Department

Hand (feed) Milling Machines, 20-inch Water Tool Grinders, Keys and Cutters for the Woodruff Patent System of Keying, Presto Drill Chucks, Collets and Friction Tapping Devices.



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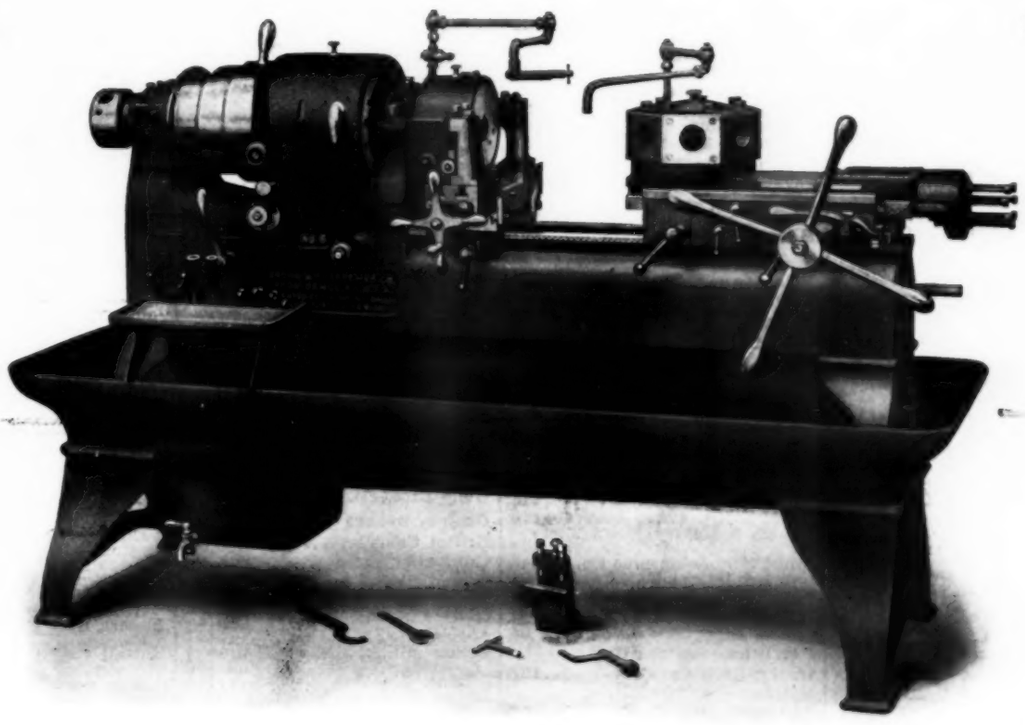
The chuck takes all sizes of round, square or hexagonal stock within the capacity of the machine without the use of additional jaws or collets.



No. 6 Wire Feed Screw Machine With Roller Feed

This feature is distinctive of B. & S. machines and is of special importance as it eliminates any need for additional jaws or collets for the different shapes of stock. The jaws of the chuck are hardened, interlock and will take stock from $\frac{1}{2}''$ to $1\frac{1}{2}''$ heavy duty and from $\frac{1}{2}''$ to $2''$ ordinary duty.

The chuck also automatically compensates for any ordinary variation in the size of stock. This saves much time that was formerly spent in adjusting the chuck for every slight change in the size of the bar.

The roller feed is located close to the chuck and short pieces of stock can be fed. This obviates the necessity of using another bar to follow up short pieces.

Our General Catalogue shows a full line of Wire Feed, Plain and Automatic Screw Machines.

Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

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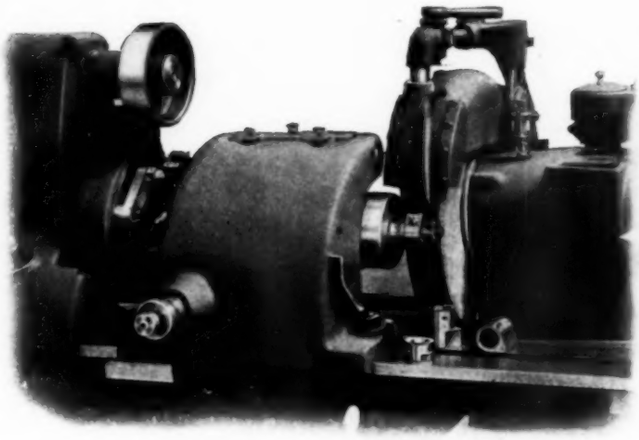
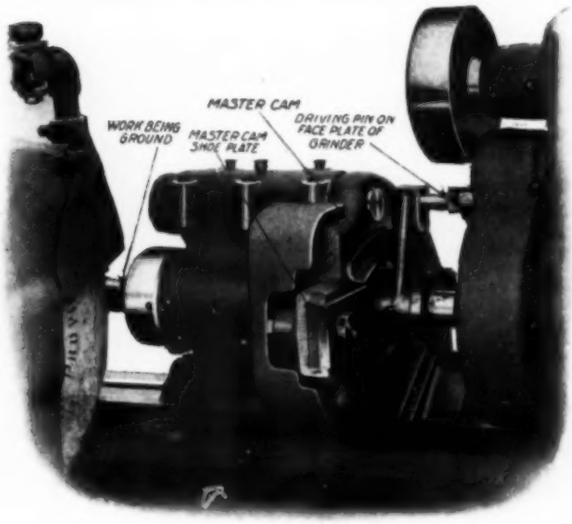


FRONT VIEW



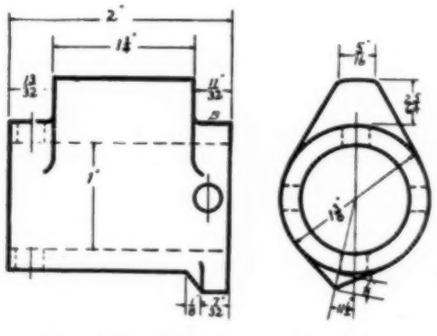
REAR VIEW

How Detachable Cam Grinding Is Done On The Landis Grinder

The above views show an attachment for grinding detachable cams which has been designed for use on our Regular Universal and Plain Grinders.

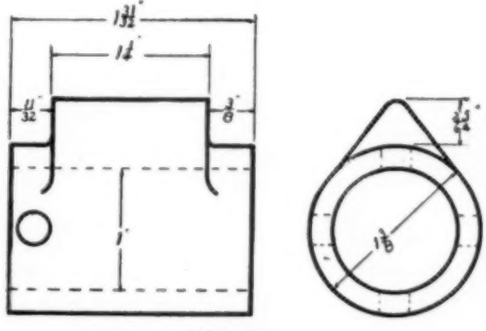
It is applied to the machine by simply bolting to the table and connecting the driving arm on the end of the spindle with the regular work drive on the face plate as shown, requiring no alteration whatever in the machine itself. The main features of this attachment are that it grinds its own master cams and reproduces the cam forms precisely. The masters are copied from models of the work to be ground and the operations in doing this are so simple that users can make these themselves. The cams shown by the line cuts are just a few examples of work ground by this attachment. The exhaust cams with compression release toes were ground just as easily as single cams.

Write for Catalog "A."



Exhaust Cam with Compression Release.
Grinding time, 10 per hour.
Ground on "Landis" Cam Grinding Attachment.

Material, steel hardened.
Stock removed, .020" diameter.
Finish, first-class.
Wheel used, Corundum No. 24 Comb. Grade L.



Inlet Cam.
Grinding time, 15 per hour.
Ground on "Landis" Cam Grinding Attachment.

Material, steel hardened.
Stock removed, .020" diameter.
Finish, first-class.
Wheel used, Corundum No. 24 Comb. Grade L.

Landis Tool Company, Waynesboro, Pa.

New York Office, Fulton Building, 50 Church Street, Walter H. Foster & Co., Managers.

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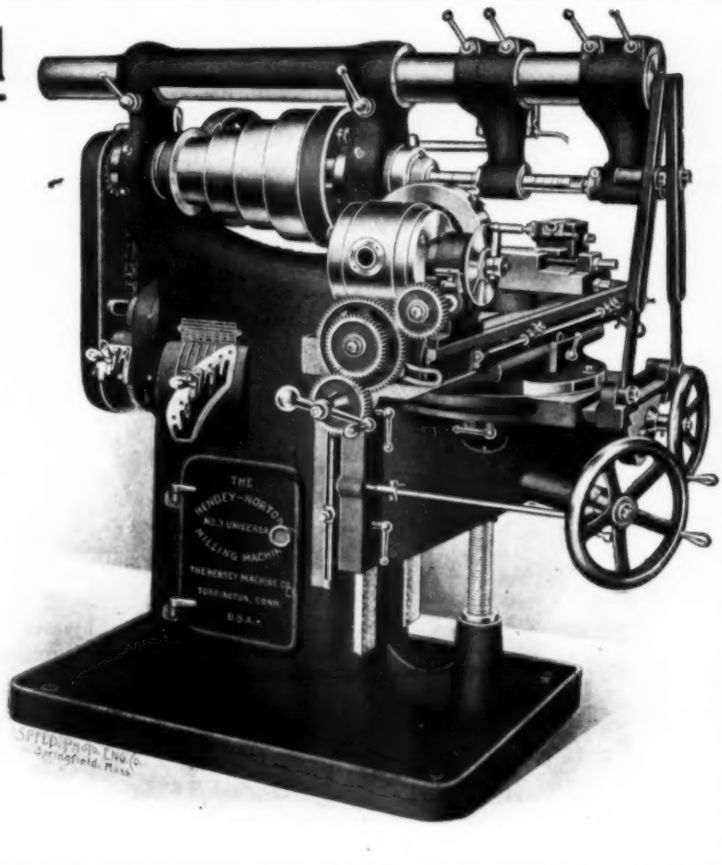

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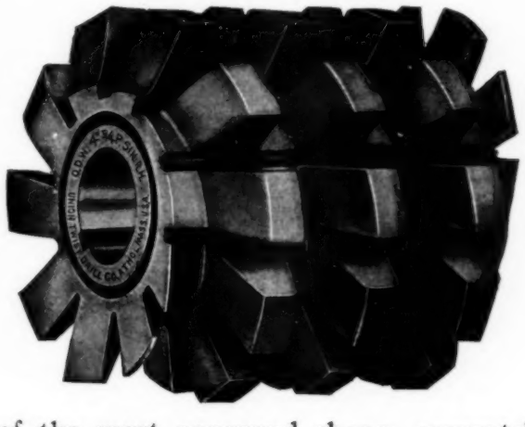

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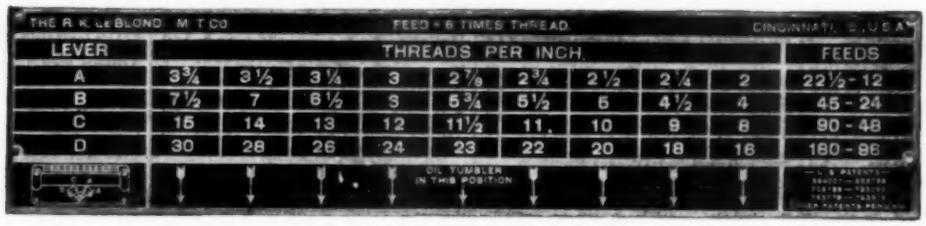
THE R. K. LeBLOND M. T. CO.
FEED = 8 TIMES THREAD.
CINCINNATI, O., U. S. A.
LEVER
THREADS PER INCH.
FEEDS
A 3¾ 3½ 3¼ 3 2⅞ 2¾ 2½ 2¼ 2 22½-12
B 7½ 7 6½ 3 5¾ 5½ 5 4½ 4 45-24
C 15 14 13 12 11½ 11 10 9 8 90-48
D 30 28 26 24 23 22 20 18 16 180-96
OIL TUMBLER IN THIS POSITION

The Quick Change Gear Mechanism is supplied on engine lathes to enable the operator to obtain the correct lead or feed for the work in hand instantly.

To secure this result, two conditions are necessary--the number of operating levers must be reduced to a minimum and placed close together, and the index plate must be direct reading, indicating the correct setting at a glance.

LeBlond Quick Change boxes have only two operating levers, located about three inches apart, which give thirty-six changes.

Inspect the reproduction of our index plate shown above, and then think of the mental calisthenics necessary to read the index plates on other so called quick change lathes.

This is only one of the many reasons why LeBlond lathes are reducing costs wherever installed.

The R. K. LeBlond Machine Tool Co.

Cincinnati, Ohio.

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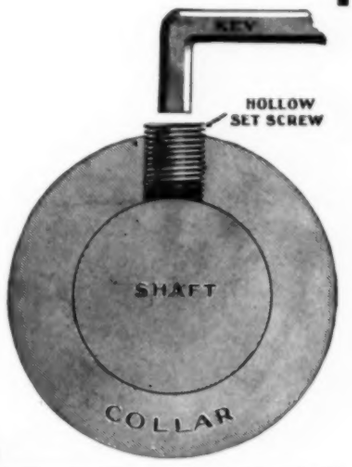

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A DOCTOR must pass an examination before he can hang out a sign.

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